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FRACTURE OF A SMALL PORTION OF THE TYMPANIC PLATE OF THE TEMPORAL BONE FROM EFFORTS TO REMOVE A PIN SUPPOSED TO BE IN THE EAR.

By THOMAS BARR, M.D.,

SURGEON TO GLASGOW HOSPITAL FOR DISEASES OF THE EAR; LECTURER ON AURAL SURGERY, ANDERSON'S COLLEGE, GLASGOW, ETC., ETC.

A woman, aged about fifty years, evidently of a nervous disposition, was brought to me on the 18th June last for the purpose of having a pin, which was supposed to be imbedded in the walls of the left internal auditory canal, removed. In order to allay itchiness in the ear she had been in the habit of scratching the external meatus with a pin, and her story was that, four weeks previously, she awoke at four o'clock in the morning just at the moment that a pin, with which she had been picking her ear while half asleep, had slipped into the passage of the ear. She was excessively alarmed, and the family doctor was at once sent for, who made efforts, by means of forceps, to remove the pin from the ear, but ineffectually. In the evening of the same day these efforts were renewed with greater determination and perseverance, so that for an hour and a half (according to the statement of the patient and her husband) *something* was pulled at with strong forceps by the doctor, whose arm was helped by the husband, so as to make the traction more powerful. At length a snap was heard, supposed to be due to the breaking of the pin into two parts. No fragment of a pin, however, was ever seen to come out. The ear now bled freely, poultices were ordered, and she was told that the pin would suppurate out. The poultices were continued night and day till her visit to me. During these four weeks she suffered greatly, partly from pain, but chiefly from anxiety due to her firm belief that a pin was in the interior of her ear, and might lead at any moment to the most disastrous consequences. Indeed, she asserted that since the occurrence sleep had almost entirely left her.

On examination, there was purulent secretion in the orifice of the ear, and, on removing this, a polypoid growth was seen to fill the lumen of the canal not far from the outer orifice, and having its base in the antero-inferior part of the canal. The growth was removed with the snare close to its root, which was found by means of a probe to cover an orifice in the soft parts leading to a hard, rough, slightly movable substance, just in the situation of the outer rough edge of the tympanic plate. No trace of a pin, or of any part of one could be found in the whole of the external auditory canal, which was seen in every part. In the antero-superior quadrant of the tympanic membrane, however, a small perforation existed, from which some muco-purulent secretion escaped from the tympanic cavity. The hearing power was very defective: Watch, $\frac{C}{40}$; increased to $\frac{2}{40}$ after Politzerization. Tuning-fork applied to middle line of head was heard more loudly in this ear.

On the first examination it was impossible to decide whether the rough, hard substance felt with the probe was bone or a metallic substance. But on examining again with the probe, on the following day, the sensation seemed to favor the view that it was bone, and not a metallic substance, a view which was confirmed a few days afterwards when I withdrew with forceps from the wound in the canal two small pieces of semi-dead bone, evidently from the edge of the tympanic plate. It was difficult for a time to persuade the woman that no pin existed in her ear. "I can feel it," she said, and it seemed that during these weeks she frequently touched the bone with the blunt end of a darning-needle, and naturally believed that this was the lost pin. After the pieces of bone came away I still felt for a few days the firm bare edge of the tympanic plate, but the wound gradually healed, and in about two weeks from the time of the removal of the bone it had entirely healed. Before that time had elapsed the perforation in the tympanic membrane had cicatrized under treatment by cleansing, drying, and inflation. Simultaneously the hearing power markedly improved. I heard from her on the 3d of Sept., and then she felt the ear to be quite well.

This is another of many instances which have been recorded of the evil consequences which may ensue from attempting, by means of instruments, to remove a foreign body from the ear before it has been ascertained, through

inspection of the whole of the external auditory canal, that a foreign body is really present. In this case, what occurred was probably the following: The pin either did not pass into the canal of the ear at all, or, if it did, must have slipped out soon after, unknown to the patient. The doctor, taking the woman's view for granted, assumed that the pin was in her ear. In his attempt to lay hold of something, the antero-inferior angle of the canal, at the junction of the cartilaginous and osseous portions, was probably grasped, and an aperture made by the forceps in the skin and membrane connecting the cartilage with the tympanic plate. The rough edge of the tympanic plate would then be readily seized with the points of the forceps, conveying to the operator the idea that some part of a pin, firmly imbedded somewhere, was being grasped, and so justifying to him the strong efforts of traction being continued. If the tympanic plate of a dried temporal bone be examined, it will be seen how readily this part of the bone would be laid hold of, and how it might be pulled at for a long time without effect. The snapping sound heard at last was probably due to the breaking of a portion of the edge of the bone, the broken portions being those which came away four weeks afterwards. The subsequent inflammation, aided by the constant poulticing, accounted for the suppuration, polypus, and perforation in the tympanic membrane.

EXAMINATIONS OF THE AUDITORY ORGAN OF SCHOOL-CHILDREN.*

By Dr. FRIEDRICH BEZOLD, Munich.

Translated by Isidor Furst, New York.

(*With four plates of curves and three wood-cuts.*)

RESULTS OF THE EXAMINATION OF THE EXTERNAL AUDITORY CANAL AND THE DRUM MEMBRANE.

ACCUMULATIONS OF CERUMEN.[1]

a.—Hindering Examination and Partly Occluding the Lumen.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	79	60	18	10	167	7.1	8.4	6.1	4.2	7.2
Protestant school .	73	67	15	13	168	13.4	14.2	8.5	14.6	13.1
Holland's Institute	(10)		(3)		(13)	(5.2)		(10.0)		(5.9)
Boys	73	58	12	11	154	9.0	11.4	6.0	8.5	9.4
Girls	79	69	21	12	181	9.3	10.1	7.7	7.2	9.2
Boys and girls . .	152	127	33	23	335	9.16	10.68	7.02	7.77	9.27

* Concluded from page 209.

[1] I have here recorded all those accumulations which obstructed the view of a part of the drum membrane, especially the region of the short process or the light spot, but allowed a portion of the drumhead to be inspected. The slightly larger figures in the Protestant school are probably due to the fact that they were more accurately recorded. But as there were found in this school nearly double the number of *occluding* plugs present in the common school, we might suspect some connection with the season. The common school was examined in summer, the Protestant school in winter.

Here we find on comparing the four columns, aside from Holland's Institute where the number examined was too small, that there is no increase in the percentages among persons with defective hearing, but rather on an average a slight decrease. A slight increment, and that in all the series, is shown only in the second column of those hearing at 16–8 metres; and possibly we may conclude therefrom that when conjoined with other slight disturbances present, non-occluding accumulations may contribute in some degree to impair the hearing. That alone they are unable to cause impairment is shown by the results of apparently occluding accumulations.

b.—Accumulations Apparently Occluding the Entire Lumen.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	8	17	7	14	46	0.7	2.4	2.4	6.8	2.0
Protestant school .	9	12	9	18	48	1.7	2.5	5.1	20.2	3.8
Holland's Institute	(2)		(2)		(4)	(1.0)		(6.7)		(1.8)
Boys	5	15	2	21	43	0.6	2.9	1.0	16.2	2.6
Girls	12	14	14	11	51	1.4	2.1	5.2	6.6	2.6
Boys and girls . .	17	29	16	32	94	1.02	2.44	3.40	10.81	2.61

The results of the first column should be first emphasized: 17 auditory organs, the inspection of which showed a plug apparently completely occluding the osseous meatus, heard whispered speech above 16 metres and hence had to be considered normal in their function. It is very probable that in all these cases a narrow chink was present between the accumulation and the wall, though it escaped observation; but they prove how small a lumen suffices for normal hearing, and on the other hand, in connection with the result of non-occluding accumulations, how unimportant is the shape of the ear canal in reference to the function of the ear.

The percentages increase pretty regularly with greater hardness of hearing, and they do so both in the total number and in the several schools and sexes, with the exception of a single number among the boys; they rise rapidly in the last column of those hearing at from 4–0 metres to 10.81 per cent., while we find among the normal hearing only 1.02 per cent., and among all the pupils, including those with impaired hearing, 2.61 per cent. This gives us an instance how a symptom which undoubtedly is connected with hardness of hearing finds expression in our tables, and in what way we have to expect this prominence in the percentages also with the other symptoms which are of more or less importance for the diagnosis.

NORMAL DRUMHEAD REFLEXES.

a.—Triangular Reflex or Point in or near the Umbo.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	968	584	196	83	1831	86.9	81.3	66.9	40.1	78.5
Protestant school .	466	360	128	30	984	85.5	76.4	72.3	33.7	76.8
Holland's Institute	(185)		(19)		(204)	(96.4)		(63.3)		(91.9)
Boys	699	388	133	48	1268	86.5	76.2	66.8	36.9	77.0
Girls	735	556	191	65	1547	85.2	81.8	70.5	39.2	78.6
Boys and girls . .	1434	944	324	113	2815	86.44	79.39	68.94	38.18	77.89

In my original notes I have stated everywhere whether the normal reflex appeared triangular, sharp or diffuse, interrupted transversely or longitudinally, or as a simple diffuse spot or point in the umbo. However, all these various forms of the normal reflex are so irrelevant for the function, as I was able to convince myself, that I have abstained from complicating the tables by their special enumeration. All these different forms are summarized under *a.* One characteristic, however, the reflex had to

possess in order to be called normal: its point, even if diffuse, had to reach the umbo entirely or nearly; in other words, the funnel shape of the drumhead had to be present in its purity, or somewhat flattened at the point by the widening of the end of the manubrium mallei.

If we make the limits of the normal reflex thus broad, it is found among no less than 84.44 per cent. of all persons with normal hearing. Among those having successively worse hearing we demonstrate a regular decrease in its frequency, which is uniformly repeated in every single series of numbers of the above collection. These numerical relations must not be considered as a clear expression of the influence of form alterations of the drumhead on the function, —for the numbers among the persons with defective hearing are, of course, depressed besides by the greater number of occluding plugs of cerumen, of otorrhœas, and of perforations in the region of the reflex, which likewise fall in the column of defective hearing—but still this does not fully explain the great sinking of the numbers among the latter, and not a small part of the cases of absent reflex at the normal place is due to alterations of form of the drumhead in general or in the region of the normal reflex. We shall obtain a more exact expression than in the above tabulation among the divisions "absence of the normal reflex," displaced normal reflex," "atrophy," and "cicatrix."

b.—The Region of the Sulcus Reflex Covered by the Anterior Lower Wall of the Ear Canal.

Hearing distance.	Absolute numbers.					Percentages.				
	Above. 16. Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above. 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	402	251	106	49	808	36.1	35.0	36.2	23.7	34.6
Protestant school .	135	114	39	11	299	24.8	24.2	22.0	12.4	23.3
Holland's Institute	(140)		(17)		(157)	(72.9)		(56.7)		(70.7)
Boys	237	134	55	17	443	28.1	26.3	27.6	13.1	26.9
Girls	300	231	90	43	664	35.3	34.0	33.2	25.9	33.7
Boys and girls . .	537	365	145	60	1107	32.37	30.70	30.85	20.27	30.63

It was some special reason which caused me to devote more particular attention to this reflex streak at the anterior lower periphery among the other above-enumerated normal reflexes of the drumhead. The punctiform reflex on the short process, and the stripe-like or punctiform reflex at the anterior upper border of Shrapnell's membrane, were also noted wherever they were present; but as no further interest attaches to the frequency of their occurrence, I have abstained from giving a *résumé* of them in the tables.

The sulcus reflex arises in the above-described manner as a linear streak encompassing the anterior lower periphery of the drumhead. As it is produced in the curve formed by the periphery of the drumhead with the external lip of the sulcus, we may be assured, when it is completely visible, that the drumhead can be inspected by us in its entire extent, provided no pathological anomalies of form, such as exostoses in the auditory canal or accumulations, prevent us otherwise. For the anterior lower periphery of the drumhead is the only place which is frequently hidden by a more curved course of the osseous canal and a corresponding projection of the lower anterior wall of the auditory canal. If we are able to inspect this portion likewise, the drumhead in its entire extent lies before us, and I have thought it not to be without interest to ascertain how often this is really the case. The number of auditory canals in which we can make the sulcus reflex visible is, as appeared in the course of these examinations, greater than that in which it is more or less completely invisible. Therefore, subsequently the latter only were counted, among which are included all those cases in which this reflex was wholly or largely covered by the anterior lower wall of the auditory canal; other hindrances to the inspection of this region were left out of consideration.

It is not quite easy, in all the cases where there is still some possibility of seeing the reflex, to bring it to view. This is proved by the different figures I have obtained in the three schools, and which are to be explained evidently by some defect in my early technique. In Holland's Institute, which I examined first, I could not bring it to view in

70.7 per cent.; in the common school, which was next in order, in 36.6 per cent.; and in the Protestant school, examined last, only in 23.3 per cent. In order to see it as frequently as the anatomical relations will permit, the auditory canal must be energetically straightened both by traction on the auricle and by co-operative pressure against the posterior wall with the speculum, and the line of sight must run through the ear canal from behind above to in front below. Where the canal is wide and nearly straight, it can indeed often be inspected without the aid of a speculum. Rarely only is a reflex streak entirely absent at this spot, although the periphery is accessible to our eye. Hence by its frequency alone it deserves the title of a normal reflex, and we learn from this tabulation *that the anatomical relations*, at least in children, *in more than two thirds of the cases permit us to inspect the drumhead directly in its entire extent.*

The sulcus reflex suffers a pathological alteration only in so far as it may appear somewhat widened in depressions which implicate the anterior lower periphery of the drumhead. Even in other intense alterations of the drumhead, older perforations, etc., its presence may still be demonstrated; for this reason, in the above tabulation, we find a slighter decrease in its frequency in defective hearing than can be demonstrated with the triangular reflex.

We now come to the—

PATHOLOGICAL STATE OF THE DRUMHEAD REFLEXES.

a.—Absence of the Normal Reflex.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	20	37	20	21	98	1.8	5.2	6.8	10.1	4.2
Protestant school	15	20	8	6	49	2.8	4.2	4.5	6.7	3.8
Holland's Institute	(—)		(3)		(3)	(—)		(10.0)		(1.4)
Boys	27	33	18	14	92	3.3	6.5	9.0	10.8	5.6
Girls	8	24	10	13	55	0.9	3.5	3.7	7.8	2.8
Boys and girls . .	35	57	28	27	147	2.11	4.79	5.96	9.12	4.07

Into the tables were entered only those cases in which, excepting the sulcus reflex just discussed, there was no reflex present over the whole extent of the lower anterior quadrant of the drumhead, and in which the surface as a whole had not lost its lustre by maceration of the epidermis in consequence of inflammatory processes or secretion. Frequently in these cases the reflecting power of the external surface of the drumhead was positively proved by the presence of other reflexes, especially of the sulcus reflex or that on the short process and its surroundings. Auditory canals in which the free inspection of the anterior lower quadrant was interfered with were, of course, left out of consideration in the above tabulation.

As the region of the normal triangular reflex is the only one which is struck vertically by sound-waves impinging directly, we may assume that it receives the strongest impulses from these; and I think, therefore, that I can claim the presence of the normal reflex in the umbo as a postulate for a completely normal function of the sound-conducting apparatus [1]; Trautmann,[2] too, on the strength of two hundred examinations of the drumhead of children and soldiers, thinks "the function to be always reduced with alterations of the light reflexes due to anomalies of the curvature." I have shown above, on the figure of the drumhead section, in what manner a slight concave depression of the membrane as a whole may cause a complete disappearance of the normal reflex. The tabulation here given shows us that a complete absence of the triangular reflex is found not only with reduced function, but also with 2.11 per cent. of persons with normal hearing. Therefore, when this slight alteration of form of the drumhead, alone without other accompanying pathological alterations, especially without permanent occlusion of the tubes, influences the hearing distance at all, its reduction is so slight that it is altogether impossible to demonstrate it with our usual methods of examination.

If we consider the frequency of its absence among per-

[1] "Die Corrosionsanatomie des Ohres." Munich (Theodor Riedel), 1882, p. 24.

[2] Die Lichtreflexe des Trommelfelles. *Arch. f. Ohrenheilk.*, Bd. x., p. 91.

sons with defective hearing, we find both in the several schools and in the two sexes a regular increase with rising impairment of function, so that among those having the greatest hardness of hearing it is absent on the average four times as often as among the normal hearing. Symptomatically, therefore, the absence of the normal reflex cannot be called worthless.

b.—Normal Reflex Far Removed from the Umbo toward the Periphery.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	22	26	34	36	118	2.0	3.6	11.6	17.4	5.1
Protestant school .	10	22	15	15	62	1.8	4.7	8.5	16.9	4.8
Holland's Institute	(1)		(6)		(7)	(0.5)		(20.0)		(3.2)
Boys	18	17	20	15	70	2.2	3.3	10.1	11.5	4.3
Girls	14	31	29	36	110	1.6	4.6	10.7	21.1	5.6
Boys and girls .	32	48	49	51	180	1.93	4.04	10.43	17.23	4.98

Under this head were enumerated all those cases in which the normal triangular reflex had lost its point and appeared changed into a simple or divided, roundish, square, or irregular spot, whose position corresponded to the basis of the normal reflex, or usually was still farther removed toward the lower anterior periphery. In many cases this spot shows a remarkably bright lustre. That it should be accorded a separate position beside the other reflexes occurring in the anterior lower quadrant is evident by the fact alone that not rarely it can be observed simultaneously by the side of the latter. For instance, sometimes we can inspect all the three reflexes here under consideration at the same time on one drumhead: distant about the length of the absent triangular reflex from the umbo lies our roundish glossy reflex; still farther toward the periphery lies the glossy streak, which is due to the fact that the peripheral zone of the drumhead takes part but little, if at all, in the depression, and which Politzer explains as a phe-

nomenon of flexion, figured in his text-book[1]; and quite at the periphery we find, third, the above-described sulcus reflex. In these cases the three reflexes lie in such a way that they are cut in half by the line which divides the triangular reflex in two. The origin of the displaced normal reflex has been traced above to the formation of a greater pan-like depression of the drumhead, and it has been shown on the section of the drumhead that it must be considered as a true picture of a concave mirror.

Like the absence of the normal reflex, the occurrence of this alteration may be observed where the hearing distance is perfectly normal, although relative to its frequency generally it is somewhat rarer (in 1.93 per cent.).

If we trace its frequency in the successive degrees of hardness of hearing, we find throughout a uniform and much greater increase in it than in the simple absence of the normal reflex, so that it occurs on an average among those hearing at 4–0 metres in not less than 17.23 per cent., or nearly nine times as frequently as among the normal hearing. In accordance therewith is the pathognomonic value of this alteration of the reflex; in the frequency of its occurrence, as well as in its rapidly rising presence in the higher degrees of hardness of hearing, it follows directly on the "posterior fold," undoubtedly the most frequent symptom of depression.

It should be emphasized as a remarkable fact, that it is to be observed more frequently among the girls, both absolutely, and especially in the last column, containing the worst hearing; in the latter nearly twice as frequently as among the boys, although we shall see further on, in Table XXI., that the boys, on the whole, exhibit larger percentages of tubal affections than the girls.

Under *c* were included all those cases in which a reflex was present on Shrapnell's membrane which indicated concavity of the latter. It has been stated above that a stripe-like or punctiform reflex at its anterior and upper border, if present, is to be considered normal. Reflexes of *convexity* are to be rarely observed spontaneously in this region, and

[1] Bd. i., p. 306.

in that case it is not difficult to distinguish them from the reflexes of concavity, mostly by the simultaneous presence of the sickle-shaped reflex of convexity at the posterior upper periphery.

Under *d* were included all reflexes *behind* the short process, from a simple point or glossy streak on the posterior fold to the uniform lustre of the entire portion of the drumhead lying above this fold, of course excluding the occasional reflexes of convexity occurring shortly after blowing the nose.

c.—Macular Reflex ABOVE *the Short Process.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	8	8	4	3	23	0.7	1.1	1.4	1.4	1.0
Protestant school .	3	4	1	2	10	0.6	0.8	0.6	2.2	0.8
Holland's Institute	(6)		(—)		(6)	(3.1)		(—)		(2.7)
Boys	7	8	2	2	19	0.9	1.6	1.0	1.5	1.1
Girls	4	4	3	3	14	0.5	0.6	1.1	1.8	0.7
Boys and girls .	11	12	5	5	33	0.66	1.01	1.06	1.69	0.91

d.—Punctiform, Linear, or More Expanded Reflex BEHIND *the Short Process.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	18	26	17	12	73	1.6	3.6	5.8	5.8	3.1
Protestant school .	15	22	7	7	51	2.8	4.7	4.0	7.8	4.0
Holland's Institute	(4)		(1)		(5)	(2.1)		(3.3)		(2.3)
Boys	11	24	11	9	55	1.4	4.7	5.5	6.9	3.3
Girls	22	24	13	10	69	2.6	3.5	4.8	6.0	3.5
Boys and girls .	33	48	24	19	124	1.99	4.04	5.11	6.42	3.43

It appears from the above tables that although the forms *c* and *d* are to be considered pathological, inasmuch as their frequency grows almost throughout with increasing hardness of hearing, they have been met with on the one hand more rarely generally, especially the macular reflex above the short process, and on the other hand they do not increase in progression as they approach the zero point of the hearing distance, as we have seen to be the case with the normal reflex displaced towards the periphery.

A part, though small, of the reflexes of concavity in Shrapnell's membrane is to be traced, as I have learned from the clinical history of several cases, to a former perforation at this place and its closure by a cicatrix.

All these reflexes, like the displaced normal reflex, come under observation also with normal hearing distance; that *above* the short process in 0.66 per cent., and that *behind* the latter in 1.99 per cent. among those with normal hearing.

COLOR ANOMALIES OF THE DRUMHEAD.

Acute and subacute inflammatory alterations on the drumhead, which were entered under two heads, (*a*) *diffuse reddening and extravasation of blood*, (*b*) *serum perceptible in the drum cavity*, were but rarely present; injection and extravasation of blood on the whole in 0.42 per cent., and perceptible serum in 0.21 per cent.

Neither alteration causes necessarily a reduction of the hearing distance, which, despite their presence, in some cases amounts to over 16 metres for whispered speech. Although the common school was examined in summer, and the Protestant school in winter, the figures of both in these columns offer but slight differences. Their special tabulation can be of little use to us here on account of the small numbers.

The records of "diffuse opacities," comprising the cases in which the opacity was spread more or less uniformly over the drumhead, are to some extent arbitrary, because the limit between normal and pathological admixture of white to the color of the drumhead cannot be sharply drawn, and also because the varying illumination can easily lead to

deception in the estimation. In the table only the more pronounced opacities were taken note of. That they should not be passed over appears from the fact alone that of the alterations enumerated under from *a* to *d* they give relatively the most certain landmark of the presence of a disturbance of function, as becomes evident from an inspection of the four tables.

PATHOLOGICAL OPACITIES AND DEPOSITIONS IN THE SUBSTANCE OF THE DRUMHEAD.

a.—Diffuse Opacities.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	15	14	14	12	55	1.3	2.0	4.8	5.8	2.4
Protestant school .	4	13	6	—	23	0.8	2.8	3.4	—	1.8
Holland's Institute	(8)		(5)		(13)	(4.2)		(16.7)		(5.9)
Boys	10	12	10	2	34	1.2	2.4	5.0	1.5	2.1
Girls	9	15	10	10	44	1.0	2.2	3.7	6.0	2.2
Boys and girls . .	19	27	20	12	78	1.15	2.27	4.26	4.05	2.10

b.—Circumscribed Opacities.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	114	104	49	20	287	10.2	14.5	16.7	9.7	12.4
Protestant school .	59	68	30	13	170	10.8	14.4	16.9	14.6	13.3
Holland's Institute	(29)		(3)		(32)	(15.1)		(10.0)		(14.5)
Boys	80	65	30	15	190	9.9	12.8	15.1	11.5	11.5
Girls	93	107	49	18	267	10.9	15.7	18.1	10.8	13.6
Boys and girls . .	173	172	79	33	457	10.43	14.47	16.81	11.15	12.65

c.—Calcifications.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public school . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	14	6	8	7	35	1.3	0.8	2.7	3.4	1.5
Protestant school .	8	6	3	3	20	1.5	1.3	1.7	3.4	1.6
Holland's Institute	(2)		(—)		(2)	(1.0)		(—)		(0.9)
Boys	9	3	6	4	22	1.1	0.6	3.0	3.1	1.3
Girls	13	9	5	6	33	1.5	1.3	1.8	3.6	1.7
Boys and girls . .	22	12	11	10	55	1.33	1.01	2.34	3.38	1.52

d.—Posterior Streak of Opacity.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	56	42	21	11	130	5.0	5.9	7.2	5.3	5.6
Protestant school .	6	12	9	3	30	1.1	2.5	5.1	3.4	2.3
Holland's Institute	(8)		(3)		(1)	(4.2)		(10.0)		(5.0)
Boys	48	28	14	5	95	5.9	5.5	7.0	3.8	5.8
Girls	14	26	16	9	65	1.6	3.8	5.9	5.4	3.3
Boys and girls .	62	54	30	14	160	3.74	4.54	6.38	4.73	4.43

Diffuse opacity of the entire drumhead likewise comes under observation in a number of persons with normal hearing (1.15 per cent). Its frequency rises pretty regularly with increase in the hardness of hearing in the various schools and sexes, but decreases again, in early age, on an average among the highest degrees of reduction of function.

There are special points or predilection for the "circumscribed opacities," for instance, the whole or a part of the intermediary of the peripheral zone; the latter is mostly affected in the anterior lower quadrant. Relatively fre-

quently, the anterior upper quadrant likewise shows a whitish opacity over a greater extent or only in its upper angle. Dendritic opacities, which possibly owe their origin in part to the dendritic fibrous structure described by Gruber, are more frequently found in the posterior half. All these various forms of opacity and thickening of the substance of the drumhead have been grouped together under the common head of "circumscribed opacities."

They could be demonstrated with great frequency, altogether in 12.65 per cent., although slight indications were disregarded. How little their presence *per se* disturbs the auditory function appears from the fact that they exist in not less than 10.43 per cent. of the normal hearing. In the slighter degrees of hardness of hearing we observe a moderate increase in their frequency which, however, proves much smaller than in the case of the diffuse opacities. The highest grades again show a diminished number, as do the diffuse opacities.

Of "calcifications," which were most frequently found in the posterior or anterior intermediary zone, at times by the side of still persisting perforations or cicatrices of the drumhead, it has been repeatedly shown in the literature that their presence does not necessarily form a hindrance to the normal function; they exist in our examinations in 1.33 per cent. of the normal hearing. As opposed to the simple diffuse and circumscribed opacities, their frequency grows most considerably among the highest degrees of hardness of hearing—a fact which perhaps should be explained by their frequent connection with former purulent processes.

Finally a separate entry was made of the "posterior streak of opacity," because in at least a part of the cases it is distinguished from the other opacities by its mode of origin. By this short term I understand the streak of opacity which frequently extends from the short process backwards and downwards, beginning as a more or less sharp line and either (1) ending at the posterior border of the drumhead; or (2) gradually disappearing farther downward in the posterior half; or (3) merging in a further zonular opacity. It is probable, at least in conditions 1 and 2, that is has de-

veloped at the place of a former posterior fold, and thus points to preceding tubal processes, all the more because we often enough find streaks of opacity and the formation of folds at one and the same time. However, not always is the long existing flexion at this point to be considered as the most probable cause of the posterior streak of opacity. Not rarely we see the streak merely as the clearly-marked commencement of an opacity which occupies the entire intermediary or the whole or a part of the peripheral zone. In these cases it is possible that inflammatory processes, which were localized exclusively in the membrana tympani and the drum cavity, may have led to deposits at this point in particular, because by its greatest tension it gives rise with special facility to disturbances of circulation. Opacity of the whole intermediary zone, too, which is of frequent occurrence, may possibly be traceable in a part of the cases to a persistent flexion due to greater depression of the central funnel of the drumhead.

We encounter the posterior streak of opacity likewise with comparative frequency (in 3.74 per cent.) in normal relations of hearing. We meet it somewhat more frequently in hardness of hearing of various grades, but the frequency decreases again in the highest degrees. This latter circumstance, which we have seen to recur in all the various forms of opacity with the exception of calcification, might be interpreted thus: That by themselves, even if extensive and thickly deposited in the substance of the drumhead, they cause only a moderate degree of hardness of hearing, or occur, as a rule, at least in jnvenile age, merely by the side of the slighter similar pathological alterations in the sound-conducting apparatus. Possibly, in view of the slight rise of the figures which is presented by all the opacities, this small decrease of the frequency in high degrees of hardness of hearing finds a simpler explanation in the fact that this column includes also most cases of occluding plugs and otorrhœas which rendered inspection of the drumhead impossible, and, of course, enlarge the total of this column in proportion to the numbers here to be considered.

As to the pathognostic significance of the various forms of

opacity in general, the numbers found show that they possess on the whole but a slight diagnostic value. The last place in this respect is occupied by the frequent circumscribed opacities; some greater weight attaches to the posterior streak of opacity, to diffuse opacity of the entire drumhead, and, especially for the higher degrees of hardness of hearing, to calcifications.

FORM ANOMALIES OF THE DRUMHEAD.

a.—Posterior Fold.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	50	58	48	50	206	4.5	8.1	16.4	24.2	8.8
Protestant school .	10	23	19	11	63	1.8	4.9	10.7	12.4	4.9
Holland's Institute	(14)		(9)		(23)	(7,3)		(30.0)		(10.4)
Boys	37	49	33	30	149	4.6	9.6	16.5	23.1	9.1
Girls	23	32	34	31	120	2.7	4.7	12.5	18.7	6.1
Boys and girls . .	60	81	67	61	269	3.62	6.81	14.26	20.61	7.42

b.—Manubrium Mallei Widened or Short Process Projecting.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–10 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	9	17	12	7	45	0.8	2.4	4.1	3.4	1.9
Protestant school .	6	15	8	8	37	1.1	3.2	4.5	9.0	2.9
Holland's Institute	(5)		(2)		(7)	(2.6)		(6.7)		(3.2)
Boys	6	18	10	6	40	0.7	3.5	5.0	4.6	2.4
Girls	9	14	10	9	42	1.0	2.1	3.7	5.4	2.1
Boys and girls . .	15	32	20	15	82	0.90	2.69	4.26	5.07	2.27

The formation of a bend, which is changed into a more or less pronounced fold by the convexity here normally present, and which extends from the short process in the posterior half of the membrane backward and downward or ends at the posterior upper periphery, is generally regarded as an obvious pathognomonic symptom of depression of the drumhead. Its diagnostic significance is clearly marked in the above tabular statement. The posterior fold likewise comes under observation in not a small percentage of persons with normal hearing (3.62 per cent.), but its frequency rises uniformly with increasing hardness of hearing both in all the three schools and in the two sexes, and so largely that in the last column it amounts on the average to 20.61 per cent., or more than the fifth part of the children with the greatest impairment of hearing.

A greater stereoscopic prominence of the short process and the manubrium mallei is likewise included, and justly so, among the characteristic symptoms of depression of the drumhead. In accordance therewith are also the numerical relations in table *b*, which in general show a great increase toward the last column. But a comparison of the above two tables shows that the latter symptom, which indeed was only noted where it was present in a pronounced form, stands in frequency far behind the posterior fold, proportionately.

There has been left out of consideration in the tabulation another symptom which, when very pronounced, is characteristic of depression, viz., the more horizontal position of the manubrium mallei, which manifests itself in a greater foreshortening, and which authors place in the foreground among the characteristic symptoms. As we are dealing here only with differences in degree, and as it is quite impossible to draw the limit sharply between the normal and the pathological condition, I had to abstain from the start from following this symptom statistically [which is much to be regretted.—H. K.].

The condition of the reflexes was considered especially indicative for the diagnosis of local atrophic depression or of a collapse affecting the entire drumhead; and the term

atrophy was applied to all those cases in which there appeared, for instance, reflexes of concavity in the *posterior* half, and furthermore a more or less complete circle of reflexes round about in the intermediary zone, or still farther towards the periphery. Inasmuch as circumscribed atrophies and cicatrices cannot always be strictly differentiated from each other, it is possible that many a case has been included under *d* which, perhaps, had better been considered as a simple local atrophy.

c.—Atrophy of the Drumhead.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1669	1189	470	296	3614	100	100	100	100	100
Common school .	7	8	8	5	28	0.6	1.1	2.7	2.4	1.2
Protestant school .	4	9	4	4	21	0.8	1.9	2.3	4.5	1.6
Holland's Institute	(—)		(1)		(1)	(—)		(3.3)		(0.5)
Boys	2	6	6	3	17	0.2	1.2	3.0	2.3	1.0
Girls	9	11	6	6	32	1.0	1.6	2.2	3.6	1.6
Boys and girls . .	11	17	12	9	49	0.66	1.43	2.55	3.04	1.36

d.—Cicatrix in the Drumhead.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	10	16	14	10	50	0.9	2.2	4.8	4.8	2.2
Protestant school .	1	9	5	5	20	0.2	1.9	2.8	5.6	1.6
Holland's Institute	(2)		(1)		(3)	(1.0)		(3.3)		(1.4)
Boys	7	9	7	4	27	0.9	1.8	3.5	3.1	1.6
Girls	4	16	12	11	43	0.5	2.4	4.4	6.6	2.2
Boys and girls . .	11	25	19	15	70	0.66	2.10	4.04	5.07	1.

PERFORATION OF THE DRUMHEAD.

a.—With Otorrhœa.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	—	—	2	25	27	—	—	0.7	12.1	1.2
Protestant school .	—	1	1	6	8	—	0.2	0.6	6.7	0.6
Holland's Institute	—	—	—	—	—	—	—	—	—	—
Boys	—	—	1	14	15	—	—	0.5	10.8	0.9
Girls	—	1	2	17	20	—	0.2	0.7	10.2	1.0
Boys and girls . .	—	1	3	31	35	—	0.08	0.64	10.37	0.97

The term cicatrix was applied to those darker spots which were surrounded by an at least in part sharp, more pronouncedly opacified, or even calcified border, or which were found sharply circumscribed in a drumhead exhibiting intense opacities over larger surfaces, and partly also were clearly depressed.

Atrophies and cicatrices, in proportion to their frequency generally, could also be pretty often demonstrated in persons with normal hearing, both in nearly the same percentage of 0.66. Both show a nearly equal gradual increase in the numbers in successively greater degrees of hardness of hearing; only we find the cicatrices more frequent (in 5.07 per cent.) in the highest degrees of hardness of hearing than atrophy (in 3.04 per cent.). They exhibit, therefore, a similar relation as the calcifications compared with the simple opacities, although this relation is not as clearly marked as in the latter case.

Perforation of the drumhead with still persisting otorrhœa is the first division in which normal hearing is no longer found at all, and in which, besides, the greatest increase can be demonstrated in the numbers towards the zero point of the hearing distance. Both circumstances, as compared

b.—Without Otorrhœa.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	5	6	7	11	29	0.4	0.8	2.4	5.3	1.2
Protestant school .	—	1	2	3	6	—	0.2	1.1	3.4	0.5
Holland's Institute	(—)		(1)		(1)	(—)		(3.3)		(0.5)
Boys	3	4	6	7	20	0.4	0.8	3.0	5.4	1.3
Girls	2	3	3	7	15	0.2	0.4	1.1	4.2	0.8
Boys and girls . .	5	7	9	14	35	0.30	0.59	1.91	4.73	0.97

with the other anomalies of the drumhead discussed thus far, find their explanation in the fact that, where purulent otitis media is still active, a whole series of factors concur in curtailing the function; among these the chief part is played probably by thickening of the mucosa at the sound-conducting apparatus, infiltration, and inflammatory loosening of the articulations and the membranes of the fenestræ; on the other hand, in older processes, by condensations of the mucosa on points important for the conduction, calcifications, abnormal fixations, and solutions of continuity, aside from partial or total filling of the drum cavity and the auditory canal with secretion.

A smaller rise, though still greater than in all preceding anomalies, is found in otorrhœas that have run their course, with persisting perforation, at least if we take cognizance of the highest degree of hardness of hearing. But even in this division there are five auditory organs which could fully understand whispered speech at more than sixteen metres in spite of the perforation present.

In all the anomalies of the drumhead hitherto discussed, I have purposely in every case specially emphasized the number of auditory organs with normal hearing despite the visible alterations, although this fact is well known to every

observer. I have done so, in the first place, because I had at my disposal unusually large rooms for testing with whispered speech; secondly, because these observations are of importance not only for our clinical estimation and our therapeutical manipulations in anomalies of the drumhead, but are also capable of giving us physiologically valuable information about the mechanism of the sound-conducting apparatus.

In reference to the first point, we learn in connection with the manifold alterations of the reflex anomalies of form which are characteristic of depression of the drumhead, that by themselves they prove of little importance even when the entire drumhead has become atrophic. That they nevertheless possess a high value for our estimation of the single case is evident from the fact that even in auditory organs with normal function which presented symptoms of that nature, there were frequently reported *former* hardness of hearing, earache, tinnitus, or discharge, or else on examination there was found on the *other* side impaired hearing or otorrhœa still present. Depressions of the drumhead gain importance for the hearing distance only when they occur as symptoms of a *persistent* occlusion of the tubes, that is, an existing difference of air pressure between the cavities of the middle ear and the auditory canal; in other words, when, through excess of pressure, though minimal, of the external atmosphere on the outer surface of the drumhead, there is a disturbance of the exceedingly unstable equilibrium of the conducting apparatus. This equilibrium is an *a priori* postulate for its normal function, and is necessary for a normal conduction.

The greatest reduction of the hearing distance which may be caused through simple, persistent occlusion of the tube without secondary, functionally important alterations, and which may be at once changed into normal-hearing distance by simple equalization of air pressure, is by my clinical experience shown to be the hearing distance of 10 *cm.* for whispered speech—a distance which is found with uncommon frequency, especially in the first examination of the patients in question, that is to say, a reduction

to about the two hundredth part of the normal hearing distance. Where the latter is sunk still lower in tubal occlusion, normal hearing is as a rule no longer regained, or at least the hearing rises but slowly.

The slight weighting of the drumhead and thickening of its substance which it undergoes by deposits of lime and other elements does not demonstrably impair the hearing, particularly not—probably—when the periphery of the drumhead and immediate surroundings of the manubrium mallei are exempt, as is the rule especially with calcifications.

With reference to our therapeutics, these observations teach that no reliable prospect of material increase of function is furnished on the one hand by artificial destruction of atrophic portions in order to obtain more resistant tissue in their place, and on the other hand by excision of intermediary calcifications. This fact has been pointed out before by Schwartze [1] in connection with a case belonging under this head.

I know no better way for the physiological study of the sound-conducting apparatus in the living than the successive exclusion of all those parts of it about the functional importance of which we seek information. The statements given above show us, in this respect at least, how perfectly the apparatus is able to functionate despite the weighting of the drumhead with deposits, and despite the interruption of a large portion by radial and circular fibres such as are demonstrated with atrophies, cicatrices, and perforations.

With reference to the spontaneous loss and the operative removal of other single links of the chain of conduction, a large series of clinical observations is to be found in the literature. It would be a meritorious task to collect and sift them.

A more detailed report might here be subjoined of the five cases of dry perforation with approximately normal hearing distance.

Case 1.—Girl, aged ten years. Hearing distance right and left 18 metres for whispered speech. *Right*, for the watch 45 *cm.* The right drumhead shows in the umbo a round perforation the

[1] *Arch. f. Ohrenheilk.*, Bd. i., p. 142.

size of a lentil, which is bordered toward the front by the normal reflex framing the anterior margin of the perforation. Politzer's experiment makes a dry sound of perforation. *Left*, examination interfered with by cerumen ; sound of perforation cannot be produced.

CASE 2.—Boy, aged ten years. Hearing distance on both sides 17 metres for whispered speech. *Right*, normal reflex punctiform ; sulcus reflex present. Opacity of the anterior periphery ; in the anterior upper quadrant a streak of opacity running from the manubrium mallei vertically downward. *Left*, normal reflex absent ; sulcus reflex present ; calcification as the continuation of a posterior fold. Perforation in the anterior lower quadrant. Dry sound of perforation during Politzer's experiment.

CASE 3.—Boy, aged ten years. Hearing distance for whispered speech, right 17, left 15 metres. *Right*, dry perforation, occupying one fourth in the anterior half. Older and more recent extravasations of blood in the drumhead. *Left*, dry perforation, the same size as on the right, in the anterior half. Politzer's experiment fails on account of awkwardness.

CASE 4.—Boy, aged nine years. Hearing distance for whispered speech right 17, left 18 metres. *Right*, sulcus reflex present ; calcification in the anterior upper quadrant ; large perforation in the anterior lower quadrant. Dry sound of perforation. *Left*, normal reflex absent ; sulcus reflex present.

CASE 5.—Boy, aged seven years. Hearing distance for whispered speech, right 18, left 17 metres. *Right*, normal reflex triangular ; sulcus reflex present ; indication of posterior streak of opacity. *Left*, examination partly hindered by cerumen. Considerable defect of the drumhead. Politzer's experiment makes a dry sound of perforation.

The following case of extensive calcification and cicatrization deserves special mention on account of its good hearing distance.

Boy, aged eleven years. Hearing distance for whispered speech : right, twenty ; left, nineteen metres. *Right*, the triangular reflex quite diffuse ; the posterior upper portion of the drumhead forms a triangle reflecting *in toto*. *Left*, normal reflex absent. In the region of the umbo, a round, transparent cicatrix the size of a pea. The whole anterior half, with the exception of a narrow border in the periphery and along the anterior limit of the manubrium

mallei, is calcified ; the anterior half of the former perforation is limited by the calcification. A second calcification, corresponding to the transverse section of a lentil, is found in the posterior upper quadrant. Sulcus reflex present on both sides.

In one instance, in a girl aged nine years, a cicatrix was found in the posterior upper quadrant, through which the incudo-stapedial joint appeared in relief ; nevertheless, the hearing distance for whispered speech was eighteen metres.

Some *malformations*, likewise, came under observation.

In a boy aged nine years, *left* congenital defect of the external meatus and rudimentary auricle, of which only a projection the thickness of the little finger was present. *Right*, the hearing distance for whispered speech was eight metres. The tuning-fork is heard through the air with uncertainty, probably not at all on the left side ; from the vertex it sounds into the right ear.

Once I observed in a girl aged seven years a congenital fistula of the ear on the left side.

In two instances, boys respectively seven and eight years old, once on the right, once on the left side, I noted a remarkable malformation of the auricle which I have otherwise seen several times. In place of the regular concavity of the concha there is a very prominent vertical ridge completely filling the concavity, so that the concha here has lost its significance as sound-collector. Still the hearing distance of both organs was twenty metres for whispered speech.

In three cases, *congenital clefts of the palate* were discovered as causes of the ear affection.

The first case, a boy aged seven years, in whom the fissure extended to a large part of the hard palate, showed characteristically depressed atrophic drumheads. The hearing distance for whispered speech was : right, ten ; left, thirty centimetres.

The second case, a boy aged eight years, showed on examination symptoms of depression of the drumhead only on the left side. The hearing distance was : right, fifteen ; left, twelve metres. The boy had been repeatedly under my treatment for tubal catarrhs.

The third case, a Latin scholar aged fifteen years, who some years ago had had bilateral otorrhœa after scarlatina, shows on both sides symptoms of depression and calcification ; on the left,

adhesion of the incudo-stapedial joint to a cicatrix. Hearing distance: right, fifteen; left, five metres. In the last-mentioned two boys the fissure affected only the soft palate.

One *affection of the auditory canal* deserves brief mention on account of its *total absence*, apparently, in childhood, viz., *true exostoses and hyperostoses of the osseous meatus.*

In the three years comprised in my last clinical report, special entry was made of all exostoses and hyperostoses which came under observation; I could demonstrate their occurrence in twenty-one persons, ten times bilaterally and eleven times unilaterally. Two of the unilateral patients had suffered for years from chronic suppuration of the middle ear, with total destruction of the drumhead; in one case there were, besides, proliferations in the drum-cavity. In both cases the exostosis showed an uneven surface, with irregular epidermal covering. One occurred in an adult aged thirty, the other in a boy aged fourteen years. This form, which represents merely an ossification of the granulation tissue, and which has been described by others and myself, should not be confounded with true exostoses, which are distinguished by their smooth, spherical surface, their generally uniform, pale, thin covering of cutis, and their frequently symmetrical position on both sides.

The latter form I have seen exclusively in adults, and rather more frequently than previous authorities, if we exclude artificially deformed skulls, viz., in 0.5 per cent. of all patients and in 0.6 per cent. of adults. It was interesting to me to be able to demonstrate that among the 1918 school-children examined they were not once present. The reports on exostoses in the literature refer likewise exclusively to adults, as far as I am able to judge.

Finally it should be stated that foreign bodies were four times present in the auditory canal; twice the Blatta orientalis, once a fly, and once a flea adhering to the drumhead. The hearing distance in the four cases was within the normal limits.

The following table gives us information about the twenty-seven children in whom nasal speech was present and records the hearing distance of their fifty-four auditory organs.

NASAL SPEECH.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	—	6	9	13	28	—	0.8	3.1	6.3	1.2
Protestant school .	3	2	8	13	26	0.6	0.4	4.5	14.6	2.0
Holland's Institute	(1)		(5)		(6)	(0.5)		(1.67)		(2.7)
Boys	1	4	11	12	28	0.1	0.8	5.5	9.2	1.7
Girls	2	4	6	14	26	0.2	0.6	2.2	8.4	1.3
Boys and girls . .	3	8	17	26	54	0.18	0.67	3.62	8.78	1.49

Wilhelm Meyer, in his paper on adenoid vegetations in the naso-pharyngeal cavity,[1] which illuminates the subject in all directions, has also reported on extensive investigations in schools, made with a view to ascertain their frequency. Among 2,000 school-children in Copenhagen, 20, or 1 per cent., had the "dead pronunciation" so sharply characterized by him, and in a London school, of 700 children, 13, or 1.8 per cent. Digital examination proved that this was based throughout on adenoid vegetations in the naso-pharyngeal space. The close causal connection of ear affections with these proliferations has likewise been statistically ascertained by Meyer, he having found, among the 175 observations of adenoid vegetations then reported, 130 cases of ear disease.

In the above table only those cases were recorded in which the occlusion of the nose was permanent. In some of the children examined, who were proper subjects of poliClinical treatment, the adenoid vegetations could be demonstrated rhinoscopically and removed by operation.

As regards the frequency of permanent nasal speech, the table shows that our interior country is no way behind the coast lands, it having been present in my examinations

[1] *Arch. f. Ohrenheilk.*, Bd. viii., p. 241.

altogether in 1.49 per cent. Although adenoid vegetations were not present in all these cases, but here and there perhaps chronic catarrhal intumescences, especially hypertrophy of the posterior end of the inferior turbinated bone as the basis of the obstruction; still we are justified, according to our clinical experience, in ascribing, at least in the great majority of cases, the presence of dead pronunciation and the characteristic mimic expression to vegetations in the naso-pharyngeal space. Besides, these different causes are at any rate of nearly equally unfavorable effect for the function of the ear. Their injurious influence on the ear expresses itself most sharply in the percentages of the above table. Normal hearing distance among children with permanent occlusion of the nose does not form the rule, but rather a rare exception; for of the fifty-four auditory organs here to be considered, only three heard normally, all the rest more or less poorly, and the increase of the numbers in the higher degrees of hardness of hearing is here much greater than we have found with the various symptoms of depression of the drumhead. Not less than 8.78 per cent. of all hearing below 4 metres had at the same time nasal speech; even among those hearing at 4–8 metres the number is still pretty large (3.62 per cent.). These high figures permit, perhaps, of the simple explanation that occlusion of the tubes, which can be demonstrated in the great majority of these cases, besides isolated suppuration of the middle ear and its residues, is here much more persistent than in the cases not complicated with complete impermeability of the naso-pharyngeal space, in which latter there remains frequently only the depression of the drumhead as the residuary symptom, while the tube has regained its patulousness some shorter or longer time previous.

FORMER EAR AFFECTIONS.

The following tables rest on the historical data furnished by the parents and guardians, which, of course, we must not expect to be complete, but be satisfied with what is attainable, giving us, as they do, valuable information.

Former Discharge.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	55	58	50	64	227	4.9	8.1	17.1	30.9	9.7
Protestant school .	9	25	25	32	91	1.7	5.3	14.1	36.0	7.1
Holland's Institute	(7)		(6)		(13)	(3.6)		(20.0)		(5.9)
Boys	38	34	34	42.	148	4.7	6.7	17.1	32.3	9.0
Girls	26	49	41	54	170	3.1	7.2	15.1	32.5	8.6
Boys and girls . .	64	83	75	96	318	3.86	6.98	15.96	32.43	8.80

The statements as to preceding suppurations are pre-eminently apt to awaken our fullest attention; in the first place, because at this age they are more reliable than in the case of adults, in whom the lapse of time for accurate recollection is far too great, and the relatives, who usually have a better memory for past diseases of their wards than the latter themselves, are often no longer among the living; in the second place, because of the remarkable statistical results yielded by the following table.

The regularity with which the percentages rise, in the several schools as well as in the two sexes, with increasing impairment of hearing, was, to me, a very notable and quite unexpected fact. It is just this last table which gives us the best proof of the suitability of the classification according to hearing-quotas chosen.

Weil (*l. c.*) likewise states in regard to his examination of schools that a large number of children in Stuttgart had suffered, according to the history, from otorrhœa in the past: "Thus, for instance, in the Eberhard school, of the 1,105 children, besides the 26 affected with suppuration, 60 stated that they had formerly had otorrhœa. . . . The *suppuration*, therefore, had *ceased spontaneously* in by far the majority of cases!" What influence the preceding

suppurative processes had exercised on the *function* of the ear escaped Weil's observation, because, in his tables, he did not bring the existing and antecedent disturbances into relation with the grade of the hearing distance.

The importance of former suppurative processes for the subsequent hearing power becomes most clearly marked when we represent the series of percentages, gained from the total number of children in the above table, graphically, as has been done in the adjoining curve (Fig. 3), in which the

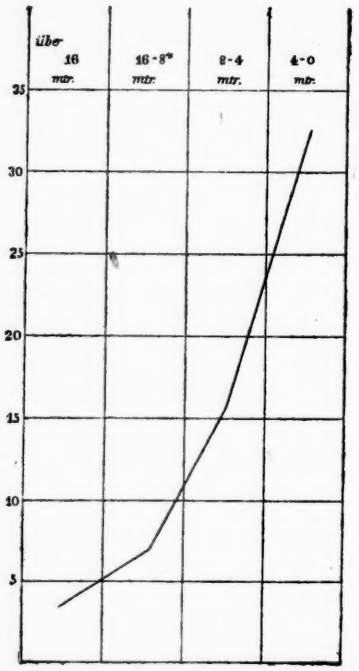

Fig. 3.

ordinals are formed from the numbers of persons with normal and defective hearing of various degrees, who had been formerly affected with suppuration. It shows clearly enough how rapidly the figures here rise towards the zero point of the hearing distance. While among those with normal acuteness of hearing there are only 3.86 per cent. with former otorrhœa, the latter is stated to have been present in 32.43 per cent. among those hearing between 4–0 metres, or nearly in *one third* among those having the highest degree of impairment of hearing.

In a large number of the children absolutely nothing could be demonstrated on the drumhead of the antecedent perforation, and merely the functional disturbance had remained as the residue of the long-past purulent inflammation. The patho-anatomical alterations which have remained in these cases might very probably be considered as analogous to those which we suppose in the so-called processes of sclerosis, and the temptation is great to conclude from the above statistical results that, in a large number of cases exhibiting little or no alterations on the drumhead, but being well characterized as affections of the middle ear by the test for osteo-tympanic conduction, especially by the aid of Weber's and Rinne's experiments, would fall at least etiologically more correctly under the diagnosis of residues of otitis media purulenta with closed perforation than under the diagnosis of otitis media catarrhalis.

Of the other antecedent ear diseases—former defective hearing, tinnitus, and earache—of which tabular statements were made, the latter two are of some interest.

As regards the presence of *subjective noises*, not much is learned on the whole from the children directly, and in the tables certainly only the higher degrees are recorded, about which the children had spontaneously spoken to their relatives. They are reported :

Among those hearing above 16 metres in							2.2	per cent.
"	"	"	at	16–8	"	"	2.6	"
"	"	"	"	8–4	"	"	5.8	"
"	"	"	"	4–0	"	"	5.8	"
"	all the children					"	3.1	"

Accordingly they seem to be more frequent in childhood than is usually assumed from clinical experience.

The former *earache* reported may give us an approximate idea in how many children acute inflammatory processes had been present in the ear. Here, of course, we cannot exclude pure otalgia, which is not so rare in children in connection with dental caries. Earache was reported :

Among those hearing above 16 metres in							4.3	per cent.
"	"	"	at	16–8	"	"	8.3	"
"	"	"	"	8–4	"	"	8.9	"
"	"	"	"	4–0	"	"	11.6	"
And in the total number of children						"	6.7	"

Finally, the statements in reference to antecedent *defective hearing* give us at least an approximate standard how great a power of observation we should presuppose in the generality of the relatives to whom the questions were directed.

I have omitted to make inquiry about antecedent *symptoms of vertigo*, because, in the absence of more detailed explanation, the relatives would have reported too many things not belonging under this head—a fact with which we become sufficiently familiar in daily practice.

GENERAL DISEASES OF ETIOLOGICAL IMPORTANCE.

Greater interest again attaches to the acute infectious diseases, in connection with which we frequently meet with complications involving the auditory organ. Weil, too, in a school with 1,105 children, has devoted attention to this causal connection. Among the children who had had scarlatina, measles, diphtheria, or several of these diseases at the same time, there were 4.1 per cent. with posterior fold and 2.5 per cent. with suppuration; among the children who had remained free from the infectious diseases, 2.2 per cent. with posterior fold, and 2 per cent. with suppuration. The former, therefore, presented 1.1 per cent. less tubal affections and 0.5 per cent. more suppuration. Of the 626 who had had infantile diseases, 30.5 per cent. had defective hearing distance; of the 479 free from infantile diseases, 33.8 per cent. —in other words, a preponderance of 3.3 per cent. of defective hearing among those who had not suffered from infectious diseases—a result which causes Weil himself to doubt its availability.

My statistical results respecting the influence of the acute infectious diseases on the hearing power appear from the accompanying tables.

In these tables we obtain, in the first place, as I believe, not unimportant information as to the relative frequency in general of the acute infectious diseases here considered. As the figures in this respect, gained incidentally in my investigations, are also of a more general epidemiological interest, I place them here again in juxtaposition.

a.—Scarlatina.[1]

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	240	159	67	58	524	21.5	20.2	22.9	28.0	22.5
Protestant school .	120	134	50	30	334	22.0	28.4	28.2	33.7	26.1
Holland's Institute	(64)		(8)		(72)	(33.3)		(26.7)		(32.4)
Boys	166	126	43	37	372	20.5	24.8	21.6	28.5	22.6
Girls	194	167	74	51	486	22.8	24.6	27.3	30.7	24.7
Boys and girls .	360	293	117	88	858	21.70	24.64	24.89	29.73	23.74

b.—Morbilli.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	555	375	165	105	1200	49.8	49.7	56.3	50.7	51.5
Protestant school .	308	253	91	45	697	54.7	53.7	51.4	50.6	54.4
Holland's Institute	(108)		(22)		(130)	(56.3)		(73.3)		(58.6)
Boys	401	262	93	61	817	49.6	51.5	46.7	46.9	49.6
Girls	462	366	163	89	1080	54.3	53.8	60.0	53.6	54.9
Boys and girls .	863	628	256	150	1897	51.02	52.82	54.74	50.68	52.49

c.—Rubeola.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	254	177	56	39	526	22.8	24.7	19.1	18.8	22.6
Protestant school .	86	78	30	28	222	15.8	16.6	16.9	31.5	17.3
Holland's Institute	(41)		(3)		(44)	(21.4)		(10.0)		(19.8)
Boys	147	103	34	26	310	18.1	20.2	17.1	20.0	18.8
Girls	193	152	52	41	438	22.7	22.4	19.2	24.7	22.3
Boys and girls .	340	255	86	67	748	20.49	21.45	18.30	22.64	20.70

[1] The entry in this and the following tables was likewise made according to the single auditory organs which had to be columnized with reference to their normal or reduced hearing distance, and not according to the individuals. The absolute numbers, therefore, give double the numbers of those affected with scarlatina, etc.; the percentages, however, give the correct proportions.

d.—Diphtheria.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	235	166	65	62	528	21.0	23.1	22.2	30.0	22.6
Protestant school .	131	110	31	20	292	24.0	23.4	17.5	22.5	22.8
Holland's Institute	(53)		(5)		(58	(27.6)		(16.7)		(26.1)
Boys	167	119	31	41	358	20.7	23.4	15.6	31.5	21.8
Girls	199	157	65	41	462	23.4	23.1	24.0	24.7	23.5
Boys and girls .	366	276	96	82	820	22.06	23.21	20.42	27.70	22.69

e.—Meningitis.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	23	17	5	3	48	2.1	2.4	1.7	1.4	2.1
Protestant school .	7	6	1	—	14	1.3	1.3	0.6	—	1.1
Holland's Institute	(5)		(1)		(6)	(2.6)		(3.3)		(2.7)
Boys	24	14	—	—	38	3.0	2.8	—	—	2.3
Girls	6	9	6	3	24	0.7	1.3	2.2	1.8	1.2
Boys and girls .	30	23	6	3	62	1.81	1.93	1.28	1.01	1.72

Among 1,807 children—823 boys and 984 girls—of from 6 to 13 years old (Holland's Institute was left out of consideration in the summary), the acute infectious diseases of childhood were represented by the following percentages:

Scarlatina,	23.74 %	of the	total	number,	viz.,	boys	22.6 %,	girls	24.7 %
Morbilli,	52.49 %	"	"	"	"	"	49.6 %	"	54.9 %
Rubeola,	20.70 %	"	"	"	"	"	18.8 %	"	22.3 %
Diphtheria,	22.69 %	"	"	"	"	"	21.8 %	"	23.5 %
Meningitis,	1.72 %	"	"	"	"	"	2.3 %	"	1.2 %

The numbers in Holland's Institute were usually somewhat larger, possibly because the relatives of the pupils mostly belonged to the better classes, and therefore supplied more accurate statements. The rather greater frequency of scarlatina is probably traceable to a recently preceding local epidemic, which had attacked several of the pupils.

Our illustrious medical statistician, the Royal Councillor, Dr. Friedrich Majer, who for twenty-five years has published the general reports of the Health Board in the kingdom of Bavaria, shortly before his death in the midst of his restless activity, expressed himself thus, by letter, in reply to my inquiry as to the relative morbidity of the acute infectious diseases in infantile age: "As regards the average percentage of children to the thirteenth year of life who are *attacked* by scarlatina, measles, diphtheria, and meningitis, I must state that for such a calculation we lack, in the first place, all reliable data, because the number of patients in general, and the number of those attacked by special diseases in particular, is entirely unknown; if for no other reason, because only a certain part of all diseases comes under medical treatment. We must restrict ourselves, therefore, to the number of *deaths*, etc."

We may, therefore, at all events, attach a certain importance to the above percentages of morbidity, although they are based only on the statements of the relatives and on a comparatively small material, as bearing some relation to the true figures of morbidity. With the figures of *mortality* given in the statistics, however, they can be compared at most with reference to age and sex. The *relative* frequency of attacks of scarlatina, measles, rubeola, and diphtheria admits of no comparison with the figures of mortality, because the fatality of these different diseases is very variable. In regard to the age at which the several diseases occurred, the statements of the relatives were in the main inexact or entirely absent, so that the sex alone is left to us for comparison.

According to Majer's statistical tables, there have died since 1876:

		Of 100,000 inhabitants.			Of 1,000 deaths from all causes.		
		1876–80	1881	1882	1876–80	1881	1882
Of scarlatina .	Boys .	35	56	55	10	17.5	17.4
	Girls .	30	48	52	10	17	18.7
Of measles . .	Boys .	22	17	28	6.7	5.4	8.9
	Girls .	22	16	28	7.5	5.8	10.2
Of croup and diphtheria . .	Boys .	117	145	131	35	45	42
	Girls .	106	135	119	37	48	43

In the time above stated, which chiefly concerns us for the children examined, there have died of the three infectious diseases among every 100,000 inhabitants rather less girls than boys, although the number *affected*, according to my above results, is throughout a few per cent. higher among the girls than among the boys. We obtain a better harmony between the above mortality figures with my morbidity figures, if the former are calculated on the basis of the total mortality figures in the years in question, as has been done in Majer's second series.

With reference to cerebro-spinal meningitis, Majer wrote me that in 1883 the whole number of deaths from this disease was 495—viz., 328 male and 167 female. The relative morbidity found by me for this disease in the two sexes, though based on too small figures, agrees well with the latter numbers.

As regards the demonstration of a causal connection of ear affections with the various infectious diseases here considered, Weil could not arrive at a positive result, because he did not put his questions separately for the several general diseases, which is absolutely necessary in view of their different influence on the ear. Thus, for instance, in my last triennial report,[1] among 3,787 ear patients, I could trace 185 affections of auditory organs in 121 individuals to scarlatina, but only 15 to faucial diphtheria, and 18 to measles. Therefore, the latter two infectious diseases together had not implicated the fifth part the number of auditory organs that scarlatina had done. Burckhardt-Merian,[2] among 1,950

[1] *L. c.*

[2] Ueber den Scharlach in seinen Beziehungen zum Gehörorgan. *Sammlung klin. Voträge von Volkmann*, No. 182.

ear patients, found 85 (4.35 per cent.) cases which had occurred in the course of scarlatina. Bürkner [1] and a number of authors enumerated by him obtained still greater percentages, up to seven per cent.

Possibly the influence of the infectious diseases on the auditory organ, in the mode of investigation followed both by Weil and by myself, is hidden in part by the fact that the less resistant children have succumbed to the fundamental disease. It could readily be imagined that this fate would befall mainly such children as have previously suffered from affections of the naso-pharyngeal space and consecutively of the ear, and accordingly were specially disposed to an extension of the diphtheritic process to these spaces—a fact particularly emphasized by Guye at the last International Otological Congress at Basle. In a part of the cases it is even the grave implication of the ear which, sooner or later after the general disease has run its course, leads to a fatal termination, whereby, of course, the number of those who become hard of hearing after acute infectious diseases must be greatly curtailed.

In spite of all this, in the historical results of school investigations, the influence of a part of the acute infectious diseases on the number of ear affections finds a pretty clear expression if we employ the representation by hearing-quotas chosen above.

As could be expected, this becomes most manifest in the table of *scarlatinal* diseases. We find, at least in the total number of children, a regular rise of the percentages with increasing impairment of hearing—a fact which suffers but few exception in the various schools and sexes. Of those with normal hearing, on the whole only 21.70 per cent. had had scarlatina, but among those hearing at 4–0 metres, 29.73 per cent.

Also among the children formerly affected with *diphtheria*, some influence on the ear, though not with the same distinctness, is recognizable, at least as regards the successive increase. Among those with normal hearing, we find 22.06 per cent.; among those with the worst hearing, 27.70 per

[1] *L. c.*

cent., who had been formerly affected with diphtheria. To be sure, in utilizing the latter number, we must not overlook that in this instance the statements of the relatives were somewhat lacking in accuracy, many a case perhaps having been counted as true diphtheria which was merely a complication of scarlatina.

The results obtained with *measles* I hold to be uncertain, for though we find an increase in moderate degrees of hardness of hearing, there is again a slight decrease, even as compared with the normal, among the higher degrees of defective hearing.

The results obtained with *rubeola* I hold to be worthless, in the first place on account of the small differences in numbers, and in the second place because this infectious disease can be differentiated with the greatest difficulty from the others. Thus I was struck by the fact that in some districts and at some time it was diagnosticated with extraordinary frequency, while otherwise it was reported much more rarely.

It was to be expected that not many ear diseases would be found among those formerly affected with *meningitis;* for the cases in which this disease is complicated with affection of the ear are to be sought, as a rule, not in the schools, but in deaf-mute institutions.

TRAUMA AND HEREDITY.

Trauma was given as the cause of auditory disturbances altogether only in seven organs of hearing.

Of special interest, finally, are the statistical results as to the part played by *heredity* in ear diseases, whose relative frequency, as shown by Bürkner, has been found so different by various authors—by Moos in not less than thirty-seven per cent., by Bürkner himself only in six per cent. My own statistical investigations, made in the general report on the ear patients treated in 1881–83, have furnished me pretty large numbers, viz., for otitis media simplex chronica, without symptoms of depression on the drumhead, 27.3 per cent.; for forms of defective hearing that could not be accurately localized, 36.4 per cent.; for nervous hardness of

hearing and deaf-mutism, each 22.2 per cent.; aside from other forms of disease with smaller percentages.

Let us see, in view of these figures, what is the relation of normally hearing persons, in whose families members with defective hearing are found. As in my above-mentioned report, the consideration included only the direct ascendants as far as the grandparents, and brothers and sisters. Defective hearing, due to purulent processes among the relatives, was excluded from the enumeration. Still I would not omit to state that otorrhœa among the relatives was reported comparatively often by persons with defective hearing. In my practice, too, I have been struck by the fact how often a larger series of brothers and sisters is suffering from purulent otitis media, or the same affection was formerly present in the parents.

The school-children showed the following proportions of heredity:

HEREDITY.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.	Above 16 Met.	16–8 Met.	8–4 Met.	4–0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	100	62	27	31	220	9.0	8.6	9.2	15.0	9.4
Protestant school .	66	49	29	14	158	12.1	10.4	16.4	15.7	12.3
Holland's Institute.	(38)		(10)		(48)	(19.8)		(33.3)		(21.6)
Boys	83	58	25	19	185	10.3	11.4	12.6	14.6	11.2
Girls	83	53	31	26	193	9.8	7.8	11.4	15.7	9.8
Boys and girls.	166	111	56	45	378	10.00	9.34	11.91	15.20	10.46

The table teaches, in the first place, that even among the persons with normal hearing a pretty large number, on the average ten per cent., shows hereditary affections; this number probably is too small rather than too large, as appears also from the statements in Holland's Institute with 21.6 per cent., which may be looked upon as on the whole more accurate.

The increase of heredity with augmenting hardness of hearing is not very conspicuous, at least as regards the regular rise of the figures with growing hardness of hearing. However, in the highest degrees of hardness of hearing at least, the percentages are more than one and a half times as great as among the normal hearing, and therefore some influence of hereditary factors is unmistakable. Perhaps here too, as in the exanthematic affections, the number examined is too small to furnish positive information. Besides, it should be emphasized that the diseases which my clinico-statistical results show to be chiefly influenced by heredity are comparatively rare in childhood and develop usually at a more advanced age.

FREQUENCY OF THE SEVERAL FORMS OF DISEASE, COLLATED ACCORDING TO AGE AND SEX, AND THEIR CURABILITY.

So far as the forms of the fundamental disease could be ascertained from the state of the drumhead, which was alone recorded, they are given in tables XX. and XXI. (pp. 281, 282).

Of the several classified ages, the number examined is too small to justify its representation *in percentages.* Also as to the frequency of unilateral and bilateral occurrence of the several forms of disease, we obtain much more accurate information from more extensive series of clinical observations, such as are found in otological reports. Therefore, in this place the percentages of the several diseases relative to each other and those of the two sexes are alone calculated.

If we collate the percentages of the diseases with reference to their *curability*, we find:

A.—Forms Completely and Partially Amenable to Treatment.

1. Plugs of cerumen probably occluding the ear canal	4.3	per cent.
2. Tubal catarrh	27.8	"
3. Tubal catarrh with atrophic drumhead	2.2	"
4. Acute and subacute catarrh of the middle ear	2.2	"
5. Acute and chronic suppuration of the middle ear	5.2	"
Total	41.7	per cent.

TABLE XX.

The unilateral and bilateral diseases of the ear, found in the three schools examined, collated according to the *age* of the persons affected.

	Age.	7 years	8 "	9 "	10 "	11 "	12 "	13 "	14 "	15 "	16 "	17 "	18 "	Total.
Cerumen closing the ear canal.	Unilateral.		4	1	1	1		1						8
	Bilateral.		5	2		2	1	1	1					12
Symptoms of tubal catarrh on the drumhead.	Unilateral.		14	8	6	8	4	7	1					48
	Bilateral.		18	20	9	17	3	5	1	2				80
Atrophy of the drumhead.	Unilateral.		1					1						2
	Bilateral.		4	2			1	1						8
Opacity or calcification of the drumhead without depression.	Unilateral.		5	5	6	3	1	2	2				1	25
	Bilateral.		8	9	11	11	8	10	1					58
Otitis med. catarrh. acuta and subacuta, injection, extravasation of blood, serum.	Unilateral.			1										1
	Bilateral.		2	4	2	1								9
Otitis media purulenta acuta and chronica.	Unilateral.		2	2	2	5	3	1						15
	Bilateral.		1	2	1	4								9
Residues of otitis media purulenta, with persisting perforation.	Unilateral.		1	1		1	2	1						6
	Bilateral.		4	1	3	3		1						12
Residues of otitis media purulenta, with cicatrix.	Unilateral.		1	1	3	2		1		1				9
	Bilateral.		2	5	5	4	2	1						20
Negative state of the drumhead.	Unilateral.		9	15	15	5	10	5	1				1	66
	Bilateral.		13	14	8	16	3	13	4					71
Cerumen hindering the examination.	Unilateral.		2	2		1	1	2						7
	Bilateral.		2	4	1	1	2	1						10
Congenital occlusion of the ear canal and rudimentary concha.	Unilateral.				1									1
Sick and not examined.			10	1	3	2	2	21	4	3				18
Total persons with defective hearing.		2	100	100	81	88	44	52						495

TABLE XXI.

The unilateral and bilateral diseases of the ear, found in the three schools, collated according to the *sex* of the persons affected.

	Cerumen closing the ear canal.		Symptoms of tubal catarrh on the drumhead.		Atrophy of the drumhead.		Opacity or calcification of the drumhead without depression.		Acute and subacute catarrh of the middle ear, injection, extravasation of blood, serum.		Acute and chronic suppuration of the middle ear.		Residues of middle-ear suppuration.				Negative state of the drumhead.		Congenital occlusion of the ear canal and rudimentary concha.	Cerumen hindering the examination.		Sick and not examined.	Total persons with defective hearing.
													a. With persisting perforation of the drumhead.		*b.* With cicatrix on the drumhead.								
	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Unilateral.	Bilateral.		
Boys. Common School II. A.	3	2	13	26		1	5	7		2	3	4		7	3	1	11	15	1		1	6	111
Boys. Protestant School II.	1	4	10	11		2	4	9		2	1		1	2	1	5	17	15		3	1	7	96
Boys. Holland's Institute		1	1	5			3	1		1			1		1		4	2					20
Girls. Common School II. A.	2	2	17	31	1	3	10	34	1	2	9	4	4	2	3	11	26	25		2	6	3	198
Girls. Protestant School II.	2	3	7	7	1	2	3	7		2	2	1		1	1	3	8	14		2	2	2	70
Total boys	4	7	24	42		3	12	17		5	4	4	2	9	5	6	32	32	1	3	2	13	227
Total girls	4	5	24	38	2	5	13	41	1	4	11	5	4	3	4	14	34	39		4	8	5	268
Total boys in percentages[1]	5.3%		31.6%		1.4%		13.9%		2.4%		3.8%		5.3%		5.3%		30.6%		0.5%				100 %
Total girls in percentages	3.6%		24.7%		2.8%		21.5%		2.0%		6.4%		2.8%		7.2%		29.1%						100 %
Total boys and girls in percentages	4.3%		27.8%		2.2%		18.0%		2.2%		5.2%		3.9%		6.3%		29.8%		0.2%				100 %

[1] Pupils with defective hearing who were not examined otoscopically on account of disease, etc., and those in whom the examination was hindered by accumulated cerumen, though the ear canal was not completely occluded, were left out in calculating the percentages.

B.—Forms not at all or but Slightly Amenable to Treatment.

1.	Opacity of calcification of the drumhead without depression,	18.0 per cent.
2.	Residues of middle-ear suppuration with persisting perforation,	3.9 "
3.	Residues of middle-ear suppuration with closed perforation,	6.3 "
4.	Negative state of the drumhead	29.8 "
5.	Congenital occlusion of the ear canal and rudimentary concha	0.2 "
	Total	58.2 per cent.

Therefore, of the children found in the schools with ear disease, according to the state of the drumhead disclosed, 41.7 *per cent. offered a certain prospect of more or less complete cure if subjected to appropriate treatment.*

HYGIENIC REMARKS.

In regard to *suppuration of the middle ear*, which we find represented by 5.2 per cent. among the several diseases, I should like to emphasize here especially, that it would be not alone to the interest of the patients if their attention were called, perhaps by the school authorities, to the importance of this affection for the function of the ear, and furthermore for health and life in general, but also that such course would be desirable with reference to the other children attending school.

Among the total number of auditory organs examined, we have found 0.97 per cent. of active suppuration of the middle ear, and another 0.97 per cent. of temporarily quiescent suppuration with persistent perforation, which latter tend to fresh relapses of the suppuration with every additional injurious influence. Besides, it is not improbable that, in a part of the cases which were inaccessible to examination from the presence of accumulated masses in the depth of the ear canal, the obstruction was due, not to cerumen, but to crusts of inspissated pus. In the schools of Stuttgart, Weil demonstrated a still larger number of otorrhœas, namely, boys, 1.9 per cent. and girls 2.3 per cent.

Therefore, according to the results of Weil's and my own examinations, we shall not err if we assume that about in every class in schools there is at least *one* pupil suffering from suppuration of the middle ear, and, if left to itself, from temporary or permanent *fetid* otorrhœa. Such a continual

source of, at best, disgusting products of decomposition should not leave us indifferent in a place of which we are justified in making the highest hygienic demands.

I would like to show, by but a single instance, of what importance a day-by-day freshly secreting purulent and sanious patch of one person, such as is formed by a chronic purulent otitis media left untreated, may become to the rest of the pupils. My former assistant, Dr. Nathan, reports a case of otitis media purulenta chronica with polypoid proliferations, out of my practice,[1] which occurred in a boy aged nine years. The otorrhœa had existed for five years, and of late had become very abundant, so that, according to the mother's statement, the purulent, very offensive secretion usually flowed down to the shoulder during the school hours, although cleaned three times a day. (How unbearable sleeping-rooms can be rendered by the odor of otorrhoics is sufficiently proved by the complaints of the relatives.) In this last case, however, repeated microscopic examination showed that the secretion almost constantly contained Koch's *tubercle bacilli*, although the lung yielded nothing to physical examination.

I therefore consider it one of the objects of school hygiene *to exclude persons affected with otorrhœa from school so long until a rational antiseptic treatment has at least removed all fetor and, if at all possible, the discharge itself.*

INFLUENCE OF THE HEARING POWER ON THE MENTAL DEVELOPMENT.

A part of the mental pabulum which on an average becomes the property of children with senses unimpaired, must, of course, be lost to a greater or less extent to persons with defective hearing of various degrees. However, in this instance a completely normal hearing power forms only one among a great many factors which in their totality form the sum of the mental potency of the individual. For it is indubitable that in many cases the absence of stimulus caused by a moderate degree of defective hearing may be

[1] *Deutsches Archiv f. klin. Medicin*, Bd. xxxv., Heft v., p. 491, and "Arbeiten aus dem medicinisch-klinischen Institute v. Ziemssen u. Bauer," Bd. i., 2 Hälfte, p. 593.

compensated and even overbalanced by assiduous care of the relatives and teachers with such children, by appropriate literature, frequent intercourse with older children, etc., apart from the varying original capacity. Still we are *a priori* justified in assuming that, if not in the individual, yet in the examination of a large number of children, a but partial defect of this special sense, which is of importance at least in ordinary instruction, will find expression somehow in the mental development of the affected children, provided we can apply a uniform measure to them all. Such a measure, though but incidental, is furnished in schools by the rate of progress noted by the teachers in all the subjects of instruction. As I finished my examinations in Common School II. A in the month of August when the pupils were rated at the school, I placed in the following table (p. 287) the general rates of progress in relation to the grade of their hearing distance.

Among the 1,289 rated pupils of the common school, there had been found 296 who on either one or both sides heard whispered speech only at 8 metres and less; among these were 60 who heard it on both sides at 4 metres and less, and, finally, 33 who heard it on both sides at 2 metres and less. Now every single class was calculated separately in the following manner: Of each of the last-mentioned groups of hearing power, all the rates of progress were added, and from the sum was calculated the mean average place belonging to the single group of pupils with defective hearing. This average place was compared with the average place of the total number of pupils in the class in question, which is simply expressed by halving the latter number. In order to make all the classes comparable with each other, it was necessary, too, to render the number of class pupils equal to each other, which was taken at 100, so that the mean average place for the whole school is expressed by the number 50. With reference to this number, the average places were calculated which belonged to the above three groups with defective hearing.

In this way I obtained the following results of the rate of progression for the three groups with diminished hearing. The average rate of progress was:

Among those hearing on one or both sides at 8 metres and less	54.09	instead of 50
Among those hearing on both sides at 4 metres and less .	64.36	" " 50
And among those hearing on both sides at 2 metres and less	67.70	" " 50

These numbers, though gained from a comparatively small amount of material, prove distinctly that there was not alone some influence on the rate of progress, but that a successive increase of this influence can be demonstrated, corresponding to the degree of the hearing defect present.

In order to appreciate the importance of these figures fully, we must bear in mind that the degree of the hearing defect ascertained should not, in the majority of the children examined, be looked upon as a permanent and altogether unalterable condition, but that it is subject to great variation, and that, therefore, the limitation in following the instruction is not continuous, because, especially, a large number of pupils suffering from tubal catarrh, accumulated cerumen, etc., now and then will be enabled to hear again almost or perfectly normally. This intermittence and remittence of defective hearing is the main reason why relatives and teachers do not believe the children to be hard of hearing, but merely inattentive; therefore, the teachers particularly cannot be too often impressed with this condition. Despite the change in the hearing distance, the influence of the hearing expresses itself in the table even in the first group with defective hearing, the greater part of whom showed only so slight a defect as to hardly be taken into consideration in ordinary intercourse, and to remain unknown to the majority of the patients and their relatives.

Hence, I believe that in the accompanying table is furnished the first statistical demonstration that also the mental development of the individual suffers a limitation corresponding to the degree that his hearing power is diminished.

TABLE XXII.

Common School II.A.

Influence of the Hearing Power on the Rate of Progress.

	Total number of rated pupils.	Mean average rate of progress appertaining to the number of pupils.	*a.* Pupils hearing on one or both sides at less than 8 metres.		*b.* Pupils hearing on both sides at less than 4 metres.		*c.* Pupils hearing on both sides at less than 2 metres.		Among 100 pupils in each class, those with defective hearing would occupy the following average places.		
			Number.	Mean rate of progress.	Number.	Mean rate of progress.	Number.	Mean rate of progress.	*a.* Hearing on one or both sides below 8 metres.	*b.* Hearing on both sides below 4 metres.	*c.* Hearing on both sides below 2 metres.
Boys' class Ia	58	29	10	36.1	4	32.0	2	29.5	62.2	55.6	50.9
" " Ib	63	31.5	18	42.8	6	49.5	4	51.3	67.5	78.6	81.4
" " Ic	62	31	5	22.8	1	30.0	1	30.0	36.8	48.4	48.4
Girls' " Ia	61	30.5	17	30.6	5	37.0	2	40.5	50.2	60.7	66.4
" " Ib	57	28.5	9	31.3	4	33.8	1	52.0	54.9	59.3	91.2
Boys' " IIa	63	31.5	8	41.8	3	42.7	3	42.7	66.3	67.8	67.8
" " IIb	63	31.5	12	35.5					56.3		
Girls' " IIa	57	28.5	14	23.2					40.7		
" " IIb	61	30.5	15	23.8	1	50.0	1	50.0	37.4	82	82
" " IIc	56	28	16	30.0	4	40.5	2	35.0	53.6	72.3	62.5
Boys' " IIIa	59	29.5	11	28.4	1	47.0			48.1	79.7	
" " IIIb	58	29	14	37.9	4	49.3	3	55.3	65.3	85.0	95.3
Girls' " IIIa	55	27.5	17	32.6	3	25.0	1	50.0	59.3	45.5	90.9
" " IIIb	56	28	16	31.7	1	48.0	1	48.0	56.6	85.7	85.7
Boys' " IVa	61	30.5	11	36.5	2	41.5	2	41.5	59.8	68.0	68.0
" " IVb	62	31	11	38.2	3	22.3	2	9.0	61.6	36.0	14.5
Girls' " IVa	51	25.5	16	27.8	3	31.7	2	22.3	54.5	62.2	47.6
" " IVb	61	30.5	12	35.8	6	36.7	3	38.7	58.7	60.2	63.4
" " V	55	27.5	20	30.5	3	27			55.5	49.1	
" " VIa	51	25.5	15	18.4	1	34			36.1	66.7	
" " VIb	49	24.5	14	27.8	5	29.4	3	32.0	56.7	60.0	65.3
Boys' " VII	33	16.5	6	14.5					43.9		
Girls' " VII	37	18.5	9	23.1					62.4		
Sum and average place of the various groups with defective hearing, calculated per 100 pupils, respectively, in the several classes	1289		296		60		33		54.09	64.36	67.70
									instead of 50		

REVIEW.

The Organ of Hearing of the Vertebrated Animals. Morphologico-Histological Studies. By GUSTAF RETZIUS, M.D., formerly Professor of Histology in the Carolini Medico-Chirurgical Institute at Stockholm. Vol. II.—"The Organ of Hearing of Reptiles, Birds, and Mammals." Stockholm, 1884. For sale by Samson & Walli. Reviewed by S. Moos, in Heidelberg.

"With the present volume of this work I have reached the limit of the task that I set for myself to learn more fully the form and structure of the organ of hearing of the different classes of vertebrated animals, from the lowest fishes up to man."

With these words the author begins the Introduction to the second volume of this work, the first volume of which, solving the same problem of the fishes and amphibia, was published several years ago.

In the following pages we shall endeavor to show how he has grasped and completed his self-imposed giant task in the volume before us. But in view of the great extent and the importance of this work, we are in doubt that we shall be able to accomplish this. If, therefore, this communication should exceed the usual length of a book review, the reader may find the reason for this in the grand plan of the whole work, and in the conscientious elaboration of the most minute details of the several parts—two fundamental qualities, which almost alone are capable of enlightening us on the comparative anatomical and histological relations of an organ, the complicated structure of which, although it

has already often occupied the best scientific workers of several generations, shows still, notwithstanding the great advances made, so many obscure points.

The author has not undertaken to describe in this work the bony capsule surrounding the membranous auditory organ of reptiles, birds, and mammals, or to give an exhaustive anatomico-histological account of the middle-ear of man. In view of Mr. Hasse's publications on the bony capsule of reptiles and birds, and the numerous descriptions given by other distinguished investigators of that of mammals, including man, it seemed no longer necessary to do this. It is probable, however, that Retzius, at some future time, will work up the middle ear of man.

Of the extent and importance of the work before us, the reader of these pages can form some idea when he learns that 400 large quarto pages are taken up by the text, accompanying which are 39 plates, containing more than 500 illustrations. Seven plates with 91 figures are devoted to the human membranous labyrinth. The illustrations are all, without exception, accompanied by a separate explanatory text. The illustrations themselves are drawn in a masterly manner by Retzius himself, and are engraved by a number of eminent artists whose names are given in the Introduction. They are all, from the beginning to the end, a truly æsthetic treat to the eye.

But our science does not deal in æsthetic pleasures, but in facts. Let us therefore examine a little more closely the contents of the work.

The organ of hearing of reptiles is treated by Retzius in four chapters: Chelonians, Ophidians, Saurians, and Crocodiles; that of birds in three: Natatores, Cursores, Incessores; that of mammals, including man, in five: Rodentia, Pecora, Belluæ, Carnivora, Man. Each of the twelve chapters, in which altogether the membranous labyrinth of thirty-nine species is described, contains an historical introduction, giving a concise, yet complete, account of the labors of other investigators. The historical part is followed by the anatomical description and the history of development according to his own researches, based

upon which disputable and doubtful points are critically examined by the author, who, when the necessity arises, maintains his own standpoint with an agreeable modesty.

I shall omit numerous details given in the description of the membranous organ of hearing of reptiles, birds, and mammals. For reasons which the readers of these ARCHIVES will readily understand, I shall limit my examination to the chapters on the membranous auditory organ of mammals, and especially of man. In many of the works on the labyrinth which have heretofore appeared, excellent as they are, the human labyrinth is either dealt with aphoristically or is not mentioned at all. But in the work before us this is so fully described and illustrated by drawings, that the book will for all time be a trustworthy guide for all who occupy themselves with the examination of the normal or pathologically altered labyrinth.

The historical review of the auditory organ of mammals and man begins with the discovery of the membranous labyrinth by Scarpa, and as it would seem also by Comparetti; but as the review refers chiefly to the membranous organ of hearing with the ductus cochlearis, only the period beginning with the discovery of Corti is considered at length. All the works on the labyrinth that have appeared during the period intervening between the publication of Corti's famous discovery in 1851, and the publication of the author's own biological researches in 1882, are mentioned in chronological order, and as this arrangement of the works is strictly carried out, we meet the names of many authors, such as Koelliker, Hensen, Boettcher, Hasse, Waldeyer, several times in the list.

The reviews of the writings which were published during these three decennaries are as thorough as they are complete. Any one who desires to increase his positive knowledge of this subject, or wishes to get information as to the present state of mooted points in the literature of the labyrinth, will find in this historical resumé all that is worth knowing, and thus save the time that would be consumed in consulting numerous books. We thus see that Schiller's utterance concerning Kant, "When kings build, the cart-

ers are kept busy," does not apply here. In the supplement the author takes up the latest investigations concerning the lymph-channels of the inner ear, to our knowledge of which the author jointly with his colleague Key, and Boettcher, Schwalbe, Hasse, and others, have contributed so much. After this follows the special histology, but "since it was impossible to obtain sufficient and good material for the examination of the inner ear of representatives of all the orders of mammalia, I have selected from the available animals the rabbit, ox, hog, cat, and man as types for the demonstration of the organ in question. Of these animals, I have described and made drawings of the form of the membranous auditory organ. The finer histological relations are demonstrated in the rabbit, cat, and man."

We have already emphasized the impossibility of doing justice to the author with regard to his comparative anatomical labors in this review of his extensive work, and for that reason shall limit our examination to the chapters dealing with the human labyrinth.

THE ORGAN OF HEARING OF MAN.

(Plates 33–39.)

The real extent of the perilymphatic space became known only when Reissner discovered the existence of a spiral channel, which was not in communication with the scala vestibuli, and Hensen discovered that it was connected with the sacculus, and shut off from the vestibular space. Rüdinger first showed that the membranous semicircular canals are in contact with the osseous walls, and to Reichert, Henle, and Odenius we are indebted for a correct conception of the position of the membranous organ of hearing. The keystone of our knowledge of the relations of the endolymphatic and perilymphatic spaces to each other, and to the adjacent parts, was laid by Boettcher's discovery of the true or membranous aquæduct. vestibuli (ductus endolymphaticus), and its connection on the one hand with the utriculus and sacculus, and on the other with the almost forgotten sac of Cotugno in the dura mater. "A new series of experimental injections, made carefully by Retzius

through the windows of the labyrinth in embryos and adults, have demonstrated that a free communication exists between the perilymphatic space of the cochlea (scala vestibuli) and the subarachnoidal spaces of the brain and spinal cord, through the ductus perilymphaticus of the aquæductus cochlea. When in these experiments the injected fluid escaped in the subdural space, it was found to be due to the bursting of the arachnoid. Notwithstanding the important labors of Weber-Liel, the unquestioned existence of the aquæductus cochlea as a perilymphatic channel to the serous spaces of the brain has not heretofore been acknowledged." To prevent misconception, the author calls the large perilymphatic space behind the fenestra ovalis the cisterna perilymphatica vestibuli, instead of the sinus (Odenius), and further on gives of this, as well as of the whole perilymphatic space, and especially of the topographical changes in its dimensions, a clear and minute description. The topography of the scalæ, the aquæductus cochlea and the fenestra ovalis, and their structure in the embryo and in the adult, are described in a like manner.

The thin periosteum, which everywhere firmly and closely adheres to the bone, forms the boundary, and at the same time, through its fibres and bands of connective tissue, containing numerous loops of blood-vessels, serves as a means of fixation. The free surface of the periosteum and trabeculæ is lined by a continuous layer of nucleated endothelial cells.

The description of the perilymphatic space is followed by the demonstration of the membranous organ of hearing itself.

Method of preparation: $\frac{1}{4}$- to $\frac{3}{4}$-per-cent. osmic acid solution. Careful removal of bone and cartilage till the membranous organ with the nerve ramification is exposed. In embryos and the new-born this can often be done successfully. To reach the posterior surface of the utriculus and the sacculus is very difficult. With a strong scalpel, time, and patience, even the hard, bony substance of the adult auditory organ may be scraped away. As soon as a new portion of cavity of the capsule is opened, the prepa-

ration is returned to the osmic acid solution for from a quarter to three quarters of an hour, and in this manner the work is continued. Further manipulation of the preparation under water, by the aid of a simple microscope.

The author, in common with other writers, distinguishes in the membranous organ of man, a pars superior from a pars inferior. To the latter belong the sacculus with the ductus and saccus endolymphaticus and the cochlea, which is formed out of the enormously developed pars basilaris and the stunted lagena; the former includes the utriculus with its appendages, etc. Only six places of nerve termination are described: three for the cristæ of the ampullæ, two for the macula of both of the sacs, and one for the papilla acustic. basilaris.

The description of the course and the division of the nervus acusticus is noteworthy in this, that the existence in man and in other mammals of the so-called ramulus neglectus (discovered by Reichert and confirmed by Henle and others), which is said to proceed from the nervus cochlearis to the partition separating the two sacs in the vestibule, is positively denied by the author, as has also been done by Middendorp.

In describing the utriculus proprius the author speaks of a sinus superior and a sinus posterior. The first, the so-called "semicircular commissure," proceeds from the utriculus to the point where the anterior and the posterior semicircular canals meet at an angle of 35–40°. The sinus posterior is the "connecting tube" between the lower end of the utriculus and the posterior ampulla.

Next follows a description of the recessus and the macula acustica recessus utriculi, the partition wall between the two vestibular sacs at the lower wall of the recessus, which Odenius has already minutely described of man. The walls of the two sacs do not coalesce, but can be separated from each other. On the wall of the sacculus there is no ramification of nerves belonging to it; the Reichert-Henle's branch of the cochlear nerve does not exist. The whole peculiarity here, as in other mammals, consists simply in the local attachment of the wall of the sacculus to that of the recessus utriculi.

The canalis utrico-saccularis, discovered by Boettcher, proceeds from a point of constriction in the lower inner wall of the utriculus. This tube lies very closely to the inner, lower circumference of the utriculus, and at last empties in the ductus endolymphaticus sacculi.

The closing paragraph of this chapter gives a synopsis of the position and the general form of the recessus utriculi.

Next follows an exposition of the ampullæ, and their semicircular canals. The author calls the horizontal ampulla and its semicircular canal the ampulla anterior, the upper or saggital the ampulla externa, and the frontal the ampulla posterior. The form, the direction, the roof with the raphé in the epithelium, and the floor with the transverse fold, caused by the entrance of the nerve twig belonging here (septum transversum), and the crista acustica with the planum semicirculatum are all minutely described of each ampulla, and the text is elucidated by very instructive illustrations of plane and profile views, and of vertical sections of each ampulla. For a detailed statement of the slight variations in the form of the above-enumerated structures in the different ampullæ, we must refer the reader to the original.

Description of the Pars Inferior.—Sacculus: As compared with the other vertebrates, it is pushed uncommonly far inward (downward) from the utriculus. Its irregular form in man (in the ox it is pear-shaped, according to Carl) admits of no comparison; it may be conceived as a much-flattened bladder, 3–3.5 *mm.* in length, and 2 *mm.* in width, with its long axis directed vertically, its short axis running from in front backward, and with a tapering part pointing downward and outward. The inner, slightly saucer-shaped wall of the sacculus is thick; the outer is thin, slightly concave (Odenius and has at its upper end a pouch which is attached to the recessus utriculi. From the outer posterior circumference of this wall the ductus endolymphaticus proceeds outward, and its lower circumference, together with the inner wall, sends forth the canalis reuniens Hensenii in a downward direction. The inner wall receives through several small bony canals, the nerve bundles of the short ramulus sacculi, whose fibres ramify in the shape of a fan on its inner surface, and

terminate in the macula acustica, situated in the lateral wall. The whole macula is concave, and upon it lies a thin disc, of the same shape, of otoliths. Corresponding to the dimensions of the macula, the membranous wall of the sacculus is thickened (Odenius); the nerve fibres mentioned pass through it and then bend over on to the surface of the macula. Beyond the margins of the macula the wall diminishes in thickness, and by bending round becomes the outer wall of the sacculus, which backward and outward rises up and gives off the ductus endolymphaticus; above it proceeds outward in the shape of an arch and forms a cap-shaped pouch, which is fastened to the under surface of the recessus utriculi—sinus utricularis sacculi (Retzius).

From the posterior circumference arises the ductus endolymphaticus (Boettcher) as a gradually-in-size-decreasing tube with a funnel-shaped mouth. This canal takes up, on the posterior side of the utriculus, where it is already much narrower, the canalis utriculo-saccularis, also discovered by Boettcher, with a cleft-shaped opening. Compared with the conditions found in other vertebrates, it would be more correct to take the view that also in man [1] the canalis utriculo-saccularis opens into the ductus endolymphaticus sacculi, or into the sacculus, than to assume that the ductus endolymph. results from the coalescence of two tubes, the one coming from the utriculus, the other from the sacculus.

Behind the sinus superior utric., upward and outward, the ductus endolymphaticus enters the bony canal of the aquæductus vestibuli, and continues in this to the apertura aquæductus vestibuli on the posterior surface of the petrous bone, where it expands and forms the saccus endolymphaticus, a closed sac lying between the layers of the dura mater. Beyond the macula acustica the lower end of the sacculus becomes funnel-shaped and forms the canalis reuniens Hensenii which is 1 *mm.* long, and 1.5 *mm.* broad. This canal at first runs downward and then turns outward to terminate in the ductus cochlearis, slightly inward of its vestibular end, inward from the posterior ampulla. This connecting channel—it has numerous homologues in other vertebrates—has no places of nerve terminations (Cotugno Boettcher).

[1] As Carl has done in the ox.

The Ductus M. Cochlearis

of the scala med. autorum, the author divides into the pars basilaris, which in man as in all the higher mammals is strongly developed, and in the lagena cochlea which is present only in a rudimentary state. The pars basilaris he subdivides in a vestibular part (Reichert) and in a spiral part, The turn of the cochlea beginning at the canalis reuniens is called by Retzius, the basal turn, the second, the middle turn. and the third (lagena) the apex turn. The boundaries, as is well known, are not sharply defined. The division is artificial. On account of the varying width of the lagena pocket the length of the apex turn varies in different individuals; usually it measures only from $\frac{3}{4}$ to $\frac{4}{5}$ of a whole turn. The length of the whole ductus cochlearis in man is 36 *mm.* Next follow the description of the three walls of the ductus and a statement of the anatomical grounds for the variations in the size and form of the whole space in the several turns, this being triangular at the base, oval at the apex, and higher at the base than at the apex. These details are elucidated in a plastic manner on plate 35 by six figures of vertical sections through the cochlea of a man 25 years of age, on plate 14 by a series of transverse sections through the cochlea of the alligator, and on plate 18 by a series of vertical sections through the cochlea of the pigeon.

The author next describes the surroundings of the membranous ductus cochlearis, and once more refers to the relation of the scalæ. The two scalæ become narrower and even cleft-shaped in the direction toward the capsule, from the base to the apex, and wider in the direction toward the modiolus. The passage of the scala vestibuli into the scala tympani at the helicotrema is described in detail and illustrated by figs. 1 and 2, on plate 38. But whether an open, though very narrow staircase exists also in the true apex of the lagena, the author has been unable to determine.

OF THE DETAILS OF THE FINER HISTOLOGICAL RELATIONS OF THE PARS SUPERIOR AND THE SACCULUS.

We will only mention here that the author, after describing the membranous wall, states "that the papillæ or villi (Lucæ,

Voltolini, Rüdinger) of the semicircular canals are found in almost every grown individual, although in greatly varying numbers and arrangement"; "they are also found at the beginning of the ampullæ"; their significance is difficult to determine. In the new-born, Retzius has found them but once; in other animals they have never been seen. Retzius regards them as normal structures.

After describing the epithelium on the inner surface of the pars superior and of the sacculus, of the planum seminulatum and of the nerve epithelium, Retzius mentions particularly that the cells of the planum seminulatum, as well as the remaining epithelial lining of the pars superior of the human organ of hearing, contain in their protoplasma large and smaller masses of yellowish-brown pigment, which increases still more in old age.

This chapter closes with a description of the nerve epithelium of the maculæ and cristæ acusticæ in man. This shows the same structure as in the rabbit and the cat. It consists of thread-cells and hair-cells, as well as of the nerve-fibres running between them. The hair-cells are in connection with the nerve fibres, which, in their passage through the basilar layer of the membranous wall, lose their medullary sheath and enter the nerve epithelium as naked axis-cylinders. They then ascend between the thread-cells, and either proceed directly to the lower end of the hair-cells, or bend to the side, and after running in this direction for a short distance, at last end in the hair-cells. As long ago as 1871 Retzius found that the nerves are in direct connection with the hair-cells, and lately he has positively observed this connection in numerous preparations from the new-born and from adults (see plate 39, figs. 13–15 and 21). The substance of the nerve fibres forms a cup in which the hair-cell is planted, and when this falls out, only the cup remains (plate 39, fig. 14). "On the cristæ acusticæ the well-known cupula formation can be produced by the ordinary methods of preparation." With these words, which close this chapter, the author takes position, in the much-disputed question whether the cupula is something natural or artificial, with those who regard it as an artificial production, while in

former years he held the opposite opinion. Those who are especially interested in this question are advised to read the passages referring to this subject in the concluding chapter of the volume (pages 363 and 364). Based upon more recent researches, the author formulates the answer to the question of dispute as follows (*l. c.*): "In my opinion, there exists here a peculiar semifluid substance, which surrounds the hairs, and which, through the action of various reagents, coagulates more or less firmly, and often shrinks, whereby the hairs are more or less altered. At all events, Hensen is right in his objections to the formerly assumed existence of the cupula, and it is one of his many highly valued services to the histology of the organ of hearing to have shown that the cupula does not exist, but that, on the contrary, the acoustic hairs project high into the lumen of the ampullæ."

Plates 35 to 39 elucidate the description of the minute structure of the ductus cochlearis of man contained in the next chapter. Taking the middle turn as the type, the author describes the relations found here, and in connection therewith mentions the peculiarities existing in the other turns. A table giving the measurements and number of the various parts of the different turns is appended to this chapter.

The Vestibular Wall, the Membrana Reissneri, is a thin membrane without vessels, which in the middle turn is in the main spread out in a straight line. It consists of a layer of structureless connective tissue, which is here and there slightly striated. Its vestibular surface is lined by a single layer of endothelial cells and a few spindle-shaped cells, which sometimes contain pigment. Its tympanal surface is covered with a polygonal pavement-epithelium, which in places is elongated or spindle-shaped, contains yellow pigment granules, and is arranged in vortices. The round or grape-like prominences, which project from this surface like villi into the canal, are not of a pathological nature; they consist of peculiar, round, granular cells, with a more spherical nucleus. They are constantly found in all the turns. The outer wall of the membranous ductus cochlearis is intimately connected with the periosteum, from

which it cannot be separated. The connective-tissue foundation consists of a transparent, structureless ground-substance with numerous fine, branching, interlaced, and anastomosing connective-tissue fibres; the ground-substance contains also many protoplasmic, markedly granular cells, with off-shoots in various directions. This connective tissue, which is thickest in the ligamentum spirale, is traversed by numerous blood-vessels; it decreases in thickness, as periosteum, toward the scala tympani, also in the direction of the scala vestibuli, though more gradually, and at the insertion of the membrana Reissneri it is continued in this membrane as well as in the scala tympani. This connective tissue on the outer wall of the cochlea gradually diminishes in thickness up to the apex of the cochlea. The tip of the ligament. spir. is connected with the basilar membrane, which is here inserted, and whose fibrous layer is continued in the sulcus lig. spir. Upon this connective-tissue foundation rests the epithelium of the outer wall of the membranous ductus cochlearis, as it does in other animals. Next follows a minute description of the crista lig. spiral. (Boettcher) or the process of the vas prominens (Hensen), and of the sulcus lig. spir. (Boettcher), of the stria vascularis, and of the relations of the epithelium (six figures on plate 35). At the point where the epithelium is diminished in height the boundary between it and the connective tissue is so indistinct, that it must remain an open question whether epithelium or connective tissue, or a mixture of both, is present. The author decides in favor of the latter view. "With the blood-vessels a small quantity of connective tissue extends into it." In man, as in the rabbit, we see in the stria vascularis a vascular epithelium of a markedly granular appearance, containing pigment granules.

In describing the tympanal wall the author employs the term limbus for crista spiralis, the radial width of which increases toward the apex, where it is as wide again as below. The lam. spir. ossea decreases in thickness in the same direction.

The form of its vestibular surface is convex at the base, straight in the middle turn, and concave in the apex turn.

At the place of insertion of Reissner's membrane its substance is raised in the form of a low ridge, the crista memb. Reissneri, which is continued in an attenuated condition into this membrane, whereby the epithelium of this membrane passes over into that of the limbus, and the vestibular endothelium of the limbus into the periosteal endothelium of the inner portion of the lam. spir. oss. The limbus or the crista spir., the continued membranous portion of the lam. oss., is composed of a striated fibrillar ground-substance, like connective tissue, and contains numerous cells, most of which are spindle-shaped; a few capillaries pass through the under part of the limbus, but they rarely reach the vicinity of the free surface. This surface shows the well-known projections, the acoustic teeth of Huschke, between the furrows of which are placed a series of small nucleated cells poor in protoplasma. These cells the author found, by using the silver method and staining the nuclei, in the new-born and in adults, as well as in the cat and the rabbit, to extend from the depth of the furrows to the free surface of the limbus, and here to spread out as a layer over the projections, the papillæ as well as the teeth; they form with their upper ends on the free surface of the limbus a level cell-mosaic of small polygonal fields (see fig. 4, *cz*, plate 38). On tearing away the membrana tectoria the upper ends of most of them come away with it. In embryos and in adults these cells are of cylindrical form and are not in direct connection with the limbus tissue, and this is the reason why, during maceration in water, they so easily fall out of the furrows. Next follows a minute description of the teeth; they decrease steadily in size toward the apex, so that, at the end of the papilla basilaris, they appear stunted. There are 7,000 of these teeth. They project over the sulcus spir. int. Then follows an account of the labium vestibular. and the labium tympanicum. Beneath the vestibular layer of the labium tymp. run the bundles of medullated nerve fibres which course toward the habenula perforata, where the labium ceases and is continued in the membrana basilaris. The diameter of the nerve-channels (of which there are about 4,000) is largest in the middle

turn. The basilar membrane is thinner in all the turns in man than in the rabbit and the cat. Its inner zone corresponds to the floor of the tunnel, and extends from the habenula to the outer margin of the points of attachment of the outer pillar-cells, and is the thinnest part of the membrane. The outer zone, the zona pectinata, extends from here to the insertion of the membrane in the ligamentum spir. This zone very gradually increases in thickness to its outer third, and then decreases again in the direction of the lig. spirale.

By staining with rosaniline and acetate of potassa the author has been enabled to study the character and the course of the fibres in this membrane. They are very fine, and striated in a radical direction. They run parallel, sometimes singly, sometimes in bundles, thus giving a ribbed appearance to the membrane. Each millimetre contains about 680, so that perhaps, 2,400 are present in the entire cochlea. On account of the slight thickness of the membrane, the author has, however, been unable to determine positively the location of the fibres with regard to the other layers of the membrane. The author was also unable to demonstrate the second layer of fibres which is visible in the rabbit. In radial vertical sections, both surfaces of this membrane were seen to be bounded by sharply defined, even contours. A few spindle-shaped nuclei, with their long diameter in a radial direction, were found in the middle of the membrane. The tympanal homogeneous lining layer, as well as the vestibular, is but slightly developed, both in embryos and adults. The peculiar tympanal lining layer of cells with protoplasmatic, varicose processes at both poles is, on the contrary, abundantly present in all the three turns in man. This layer of cells covers the entire tympanal surface of the basilar membrane from the habenula perforata to the lig. spir. Under the floor of the tunnel the section of the narrow vas spirale is seen embedded in these cells. The structure of the basilar membrane at the ligamentum spirale has already been described above. The length of this membrane varies in different individuals, and is often not the same on both

sides of the same individual. On an average it, as well as the papilla basilaris, measures in man 33.5 *mm.*

Of the epithelial lining of the tympanal wall of the membranous ductus cochlearis, we must distinguish the papilla acustica basilaris proper from the epithelium of the sulcus spiralis internus, and from the epithelium of the zone lying outward of the papilla, the so-called sulcus spiralis externus. The epithelial lining of the floor of the sulcus spiralis internus consists of a single layer of pavement-epithelium.

The papilla acustica basilaris, or the organ of Corti of man, represents a ribbon-shaped epithelial intumescence, which lies upon the basilar membrane throughout its entire length, and is composed of the same elements as in the cat and the rabbit. It consists exclusively of epithelial cells, or their derivatives, and nerve fibres: no connective-tissue fibres are found in it. This is followed by the well-known distinctions: two rows of Corti's pillar-cells, the inner hair-cells, the inner supporting cells, the outer hair-cells, the Deiters's cells, and the outer or Hensen's supporting cells. In man, too, the nerve fibres follow a spiral and a radial course.

The author is of the opinion that in adult man, as in the cat and the rabbit, the inner as well as the outer pillars are only parts of still existing cells—the pillar cells,—and gives of them a minute description and drawings of radial, vertical sections and of surface preparations.

The Deiters's cells also are constructed and arranged as in the cat and in the rabbit. There are four (sometimes three) rows of them. They begin at the basilar membrane with small polygonal foot-plates, in the middle of which, and nearer the inner circumference, ascends a fine, fibrillar thread. This is not connected with the basilar membrane, and in radial vertical sections appears to be situated at the inner boundary line of the cell. In the upper part of the cell is contained a globular nucleus, and still higher up the transparent contents of the cell pass into a granular mass containing pigment, and in then continued into the cylindrical upper phalangeal process. These processes ascend

obliquely through the space of Nüel, pass by two hair-cells, and are inserted in the third phalanx; the author, in common with Hensen, regards the phalanges in question as the free upper end-plates of Deiters's cells. The bright thread also terminates at the phalanx after it has passed through the granular portion of the cell-body and the phalangeal process. Since in man many hair-cells are wanting in the second, third, and fourth rows, the phalanges are placed side by side, and thus fill the places of absent cells.

Between the Deiters's cells are situated the outer hair-cells. They are of cylindrical form, and their pointed lower ends are attached to the inner, granular portion of Deiters's cells. They are, however, not organically connected with these cells, and have no processes. They pass free through Nüel's space to the round holes in the lamina reticularis, which is made up of the phalanges. These holes are filled with the upper ends of the hair-cells. The outer hair-cells perish in various reagents; their form is, however, very well preserved by osmic acid. In man the granules of the cell-contents adhere less closely together than they do in the rabbit. The upper end of these cells contains a round or oval, not sharply defined, body (Hensen). The author was unable to discover that any part of the cell was connected with a nerve fibre. "All that I could make out was that the lower pointed ends of the cells touch the upper nerve fibres of the outer spiral bundles, or are in a manner inserted into them. From the free upper-end surface, which is placed obliquely to the long axis of the cell, the hairs project free into the lumen of the membranous ductus cochlearis. Each cell possesses at least twenty hairs; they are of equal length, short above, stiff, lustrous, and of the same width up to their free ends."

Viewed from above the end-surfaces of these cells present the form of a crescent or a horse-shoe (see the drawings).

THE ARRANGEMENT OF THE OUTER HAIR-CELLS.[1]

The first turn has but three rows, but these, as a rule, are arranged in a beautiful, regularly alternating, order, which

[1] Of the nine illustrations on plate 37, eight show in a very instructive manner the number and arrangement of the outer hair-cells. Only figures 1 and 2,

in the middle turn is already more or less disturbed; here the arrangement varies, a fourth row is added. The same occurs in the apex coil, but when a fourth row is present, the second and third rows are, as a rule, deranged and incomplete. Even a fifth row is sometimes seen in the middle and the apex turns, but it is represented by only a few cells, never by a complete row. Great differences in this respect prevail in different individuals; at all events, the fourth row is more numerously represented in man than in the rabbit or the dog, but it is not by any means a peculiarity of man, that would perhaps be of special interest from an anthropological point of view.

The number of outer hair-cells is estimated by the author at from 11,500 to 12,000.

The description of Hensen's outer supporting cells, and of the epithelial cells lining the basilar membrane outward of the papilla, the details of which we cannot give here, is followed by that of

THE INNER HAIR-CELLS.

They are like those in the cat and the rabbit: markedly granular, protoplasmatic cells, of elongated, irregularly cylindrical form, with the globular nucleus near the lower end. The free surface is much broadened, increased in length in a spiral direction, oval, and carries here the free glistening hairs in a straight or slightly convex line in spiral order. Each cell has at least twenty hairs, which in form and length are very similar to those on the outer hair-cells. These cells are inclined outward, and lie close to the inner pillar-cells in a spiral line; their upper ends rest in the furrows formed by the pillar-cells. Immediately inward of this line are occasionally found supernumerary hair-cells. The lower end of these cells, which is isolated with great difficulty, is jagged, sinuate, rarely rounded off, and is surrounded by a network of fine varicose nerve fibrils. The real termination of these fibrils, the author was unable to make out. Below these cell-ends, which hang down to about

with three rows each from the basilar and middle turn of an adult, show a regular arrangement in all the rows. In all the others the arrangement is irregular as far as the fifth row.

the middle of the height of the epithelium, lie the nuclei, described as "granules" by Boettcher and Waldeyer, surrounded by a network of nerve-fibres. According to the author, these nuclei are not nervous elements, but indifferent epithelial cells, which carry the nerve fibres embedded between them. The author was unable to isolate these cells in an unmutilated condition; here and there he saw a single one project as a thin, granular thread-cell from the membranous wall to the surface of the epithelium. Here some of them terminate with a long, broad, flat end-plate, inward of the inner hair-cells. The cells situated still further inward are ordinary epithelial cells, which extend to the surface of the inner end of the papilla, and inward pass over into the cells of sulcus spiralis.

COURSE OF THE NERVE FIBRES.

After emerging from the medulla, all the fibres of the acusticus are provided with a sheath of myelin and Schwann's sheath; outside of the axis-cylinder and the myelin sheath is found Schwann's sheath with its constrictions and nuclei (Key and Retzius [1]).

In the human acusticus both broad and narrow fibres are found. The myelin sheath of the latter is very varicose, Schwann's sheath follows the depressions in the myelin sheath. All nerve-cells of the acusticus are truely bipolar. Beneath the maculæ and the cristæ acusticæ the nerve-fibres give up their sheath of myelin and Schwann's sheath, to enter, as naked axis-cylinders, the epithelial layer, and to unite with the lower ends of the hair-cells. The fibres of the ramulus basilaris, on the other hand, are collected in bundles, anastomose with one another, and pass through the labium tymp. to the habenula perforata; their course can, however, be traced clearly only in the apex winding (see fig. 8, plate 38), as in the two other windings they are packed very closely together. They are manifestly covered by the nucleated sheath of Schwann as far as the upper apertures of the canals of the habenula perforata; the myelin sheath is given up somewhat sooner, especially in the apex turn, on

[1] According to Retzius this is wrongly denied by Ranvier.

entering the canal, or even before. The naked axis-cylinders, after leaving the vestibular openings of the habenula perforata, run downward toward the scala vestibuli and outward, and separate into fine varicose fibrils, which in part bend back in a spiral direction and form the not sharply bounded, first spiral strand, situated on the inner side of the inner hair-cells; from these a few filaments ascend to the vicinity of the lower ends of the inner hair-cells, which they surround as a network; but a direct connection between them does not exist. Other fibres run in a radial direction between the inner pillar cells to the tunnel space, and on their outer side, at the foot-plate angle, bend over in a spiral direction into the second spiral or tunnel strand, which, in cross-sections, is seen to run as a sharply defined, round, or oval strand, along the entire tunnel. From this are given off, at almost regular intervals, varicose bundles of various sizes, which proceed in a radial dirction through the tunnel space outward, or outward and upward, pass between the outer pillar-cells, and also in a radial direction through the so-called Nüel's space, and at the inner side of the first row of Deiters's cells enter a bundle of nerve fibres running in a spiral direction, and pursue their course with it. In man each row of Deiters's cells has, at the middle of its inner side, an outer spiral strand of fine varicose filaments running parallel with one another, which, in cross-sections, appears as a longish oval bundle, clinging close to the inner side of the bodies of Deiters's cells, and extending upward to the lower end of the outer hair-cells. The final ending of the nerve fibres has not as yet been positively ascertained.

The author describes next, the intercellular spaces, the tunnel space, and Nuel's space, which is well developed in man. Both are closed at both ends of the papilla basilaris by cells. "I never saw a direct communication between Nuel's space and the endolymphatic space through the lamina reticularis."

The membrana tectoria, or membrana Corti, is a flat, ribbon-shaped, soft, and somewhat elastic formation, which extends along the entire papilla. It is narrower in the basi-

lar winding than in the other two. It may be divided in two zones; the inner, which is very thin, is fastened to the surface of the epithelium of the limbus spiralis by a reticular cementitious substance. The inner margin of this zone lies between the angle of insertion of Reissner's membrane and the edge of the limbus vestib. The second zone of the membrana tectoria overhangs free the sulcus spir. int. and the papilla; it ascends toward the scala vestibuli in the middle and apex windings, increases in thickness in the middle, becomes thinner again toward the edge, and scarcely reaches to the outermost row of hair-cells. Occasionally there are still found in adults, especially in the apex turn on the upper plates of the outermost Deiters's cells, fragments of fibre, which are evidently the rudiments of fibres which served as points of fixation for the membrane during embryonic life. About the middle of the tympanal surface of the membrane, is found the so-called Hensen's stripe. The membrane consists throughout of extremely minute filaments, which resist the action of acetic acid; in the outer, thicker zone, they bend back toward the scala tymp., and proceed in this curved direction to the under surface of this membrane.

The description of the organ of Corti in man is followed by a statement of the number and measurement of the different parts of the labryinth of the rabbit, the cat, and man, and this is further elucidated by a tabular synopsis. Although very interesting and worth knowing, we cannot reproduce the figures here, and must refer the readers for them to the original. The reason for the differences existing between his own figures and those given by Waldeyer and Krause, the author finds in this, that Waldeyer and Krause probably found the cells and structures in question more closely packed together than he did. Thus, for instance, the author estimates the number of outer hair-cells at from 11,500 to 12,000, Waldeyer at 18,000, and Krause at as much as 19,800.

The final chapter of the work is devoted to

GENERAL REMARKS

referring to the form of the organ of hearing, as well as to the minute structure. The results obtained by him with regard to the form of the labyrinth, the author has utilized in a very interesting manner for the phylogenesis. Unfortunately space will not permit us to enter into particulars. Merely to give an instance, we will mention, however, that the careful study of the auditory organ of reptiles has established the fact that the phylogenetic development is accomplished through the class of reptiles, as the intermediate link between the amphibia on the one hand, and the birds and mammals on the other; also, that the intermediation between the "post-reptiles," or ancestors of the birds, and the true mammals, as regards the organ of hearing, takes place in a striking manner through the monotrema. Compare the investigations of Hyrtl and Ibsen on the form of the organ of hearing of the Ornithorhynchus and Echidna, which resembles very closely that of the crocodile and birds. Urban Pritchard's researches have, moreover, shown that in the Ornithorhynchus the papilla acustica has become a true organ of Corti.

In considering the second main question, the minute structure of the membranous organ of hearing, the author dwells mainly on the structure of the places of nerve terminations. For particulars with regard to this we refer to what has preceded. It is certain, according to the author, that the primary fibrils unite with the lower ends of several (2–4 or 5) hair-cells in such a way that they surround the protoplasma of the cells like a marble or as a shell, whereby a closer union is secured. Whether primary fibrils also surround the upper portion of the hair-cells before ending in their protoplasma, must remain an open question for the present. "*At all events, it is certain that the hair-cells are in direct connection with the nerve fibres. The hair-cells of the maculæ and cristæ acusticæ must therefore be regarded as true sensory cells, and their acoustic hairs retain the importance claimed for them as sensory terminal apparatuses.*"

Finally, the author gives a résumé of Corti's organ of mammals.

Up to the present, anatomical science did not possess as minute a description of the membranous labyrinth of man, as the one which the author has here given us. For this reason we have tried to give the readers of these ARCHIVES an—in many places literal—abstract from the author's description. But he who wants to have a correct conception of the whole must study, not merely read, the work itself—an arduous but highly profitable undertaking. All who do this will concur with us in the opinion that the work under consideration will remain for all time an imperishable landmark for our science; to his wreath of scientific fame the author has added a new leaf which will never fade, and by the now completed work he has raised for himself a permanent monument: Monumentum ære perennius!

With a view of placing the author's studies of the membranous organ of hearing of man within the reach of a large and more especially interested circle of readers, we may be permitted to express the wish that he may be induced to publish separately in the form of a monograph, the description of the same, with the illustrations pertaining to it, and at the same time to describe more fully than he has been able to do in the work before us, because of its length, the various methods of preparation which he has employed.

We have learned with deep regret, from the Introduction, that the author's health was seriously impaired by the arduous labors which he performed in the preparation of this work. And yet this is not at all surprising.[1] We indulge, however, in the hope that this regrettable episode was vanquished long ago. Nay, more; we hope that a kind fate has bestowed upon him a long life and uninterrupted good health, so that he may be permitted in the future to enrich our science in as great a measure as he has done heretofore, partly alone, partly in association with his esteemed friend and colleague, Axel Key, and that he himself may enjoy the fruits of his labors for many years to come!

[1] Our readers will be astonished to learn that Retzius published almost simultaneously with the work under consideration, a richly illustrated history of civilization of Finland.

INDEX TO VOL. XIV.

GENERAL INDEX TO VOLUMES VIII. TO XIV.

BOTH INCLUSIVE.

[1] General Index to Vols. I. to VII. is appended to Volume VII.